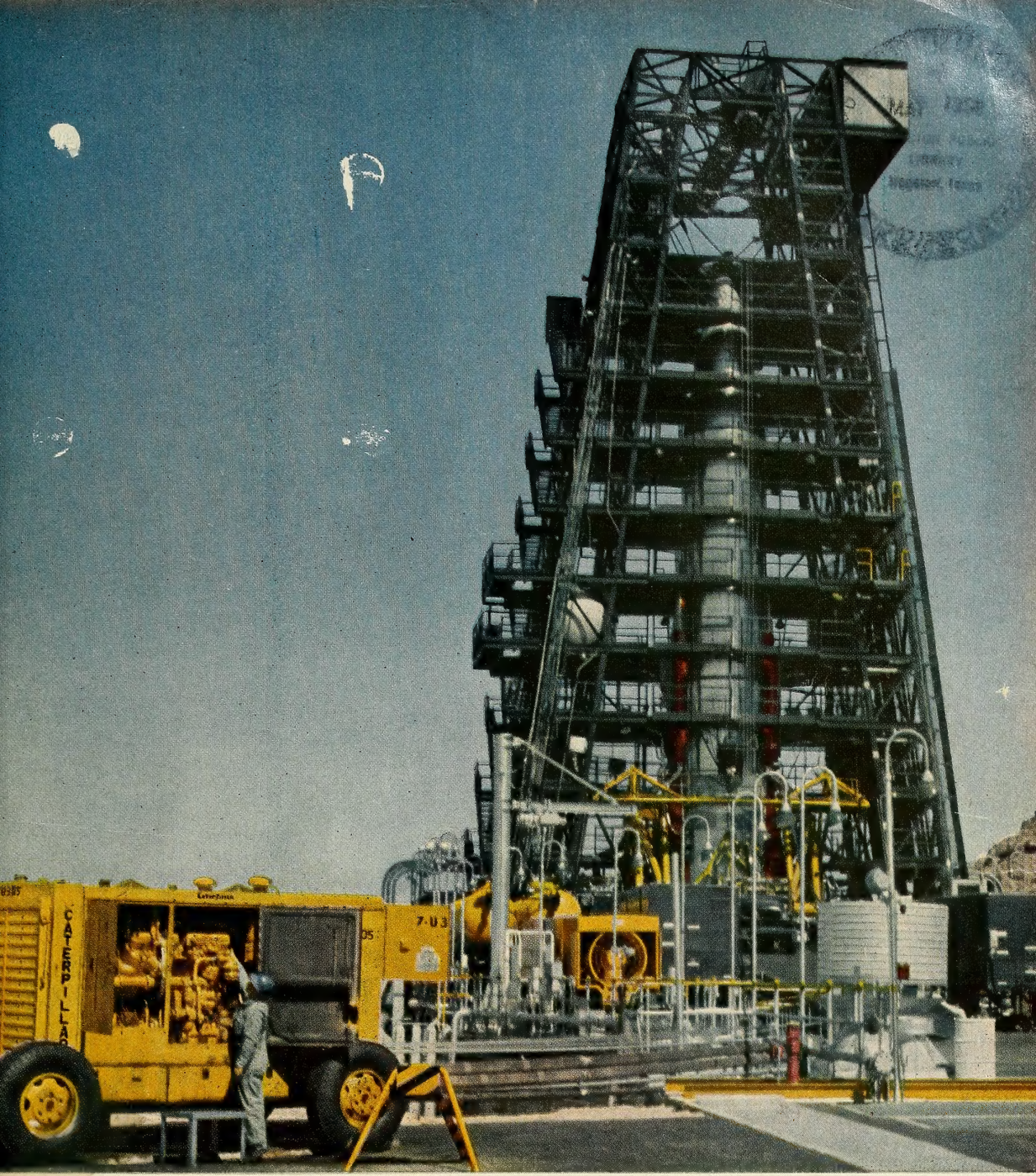
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missiles and rockets

INCLUDING MISSILE ELECTRONICS

MAGAZINE OF WORLD ASTRONAUTICS

This Issue: **SUBSYSTEMS AND COMPONENTS**

MAY, 1958



Friendly Foe

When a new air defense missile is produced, its "kill accuracy" is theoretical until it is tested against a realistic target under operational conditions. The new, supersonic missile target, **USAF XQ-4,** is one of many "friendly foes" developed by Radioplane to simulate various air enemy threats.

Duplicating the performance and radar appearance of a supersonic, high-altitude bomber, the radar-controlled XQ-4 is designed to test the seek-and-kill ability of air defense systems and their missiles.

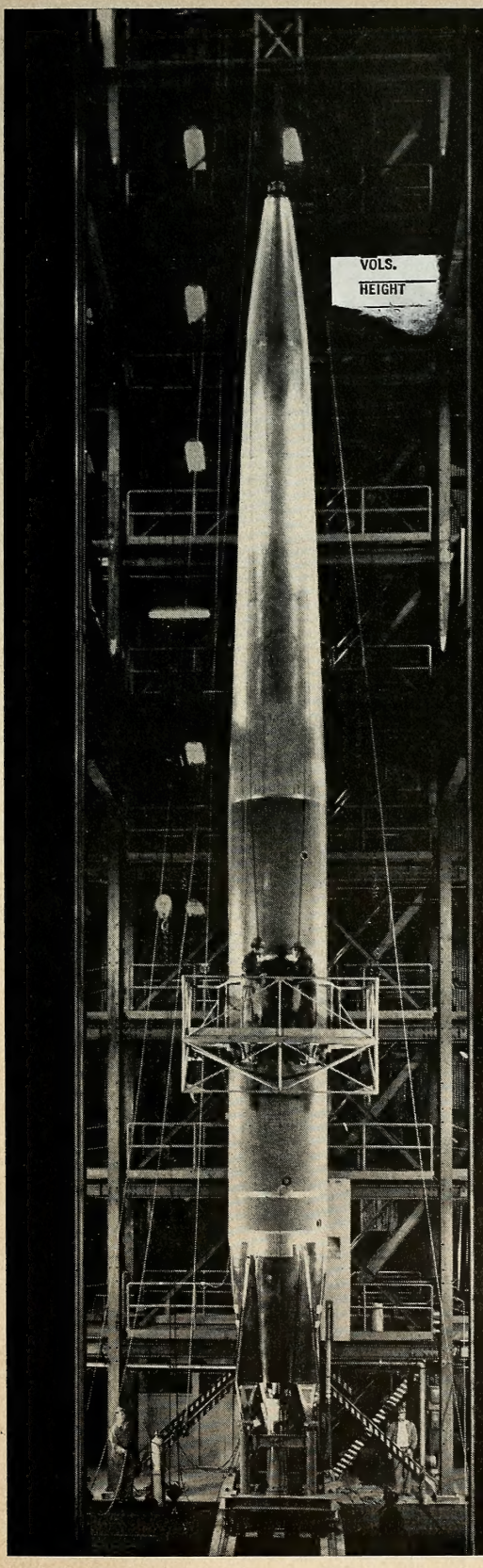
As major advancements have been made in U.S. Armed Forces air defense weapon systems, Radioplane has designed and developed targets compatible with the missions of these weapons. The XQ-4, for example, not only imitates invading bombers, but tallies up the score of hits and misses when fired upon.

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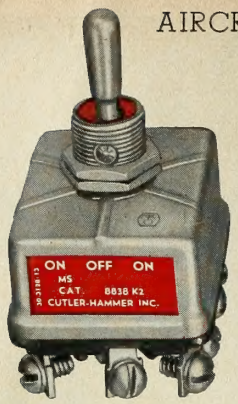
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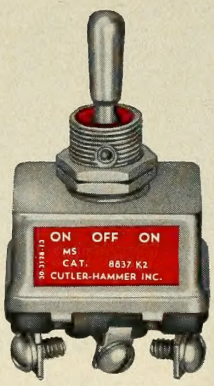
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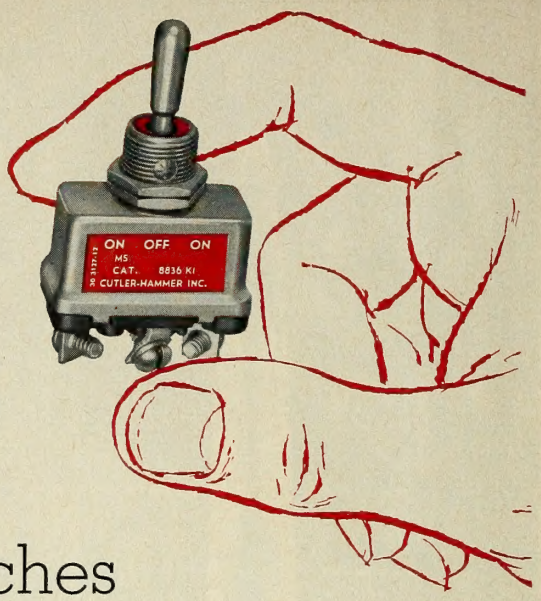
Please write to E. R. Schenkel, Missile Division Test Lab Manager, North American Aviation, 12214 Lakewood Blvd., Downey, Calif.

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missiles and rockets

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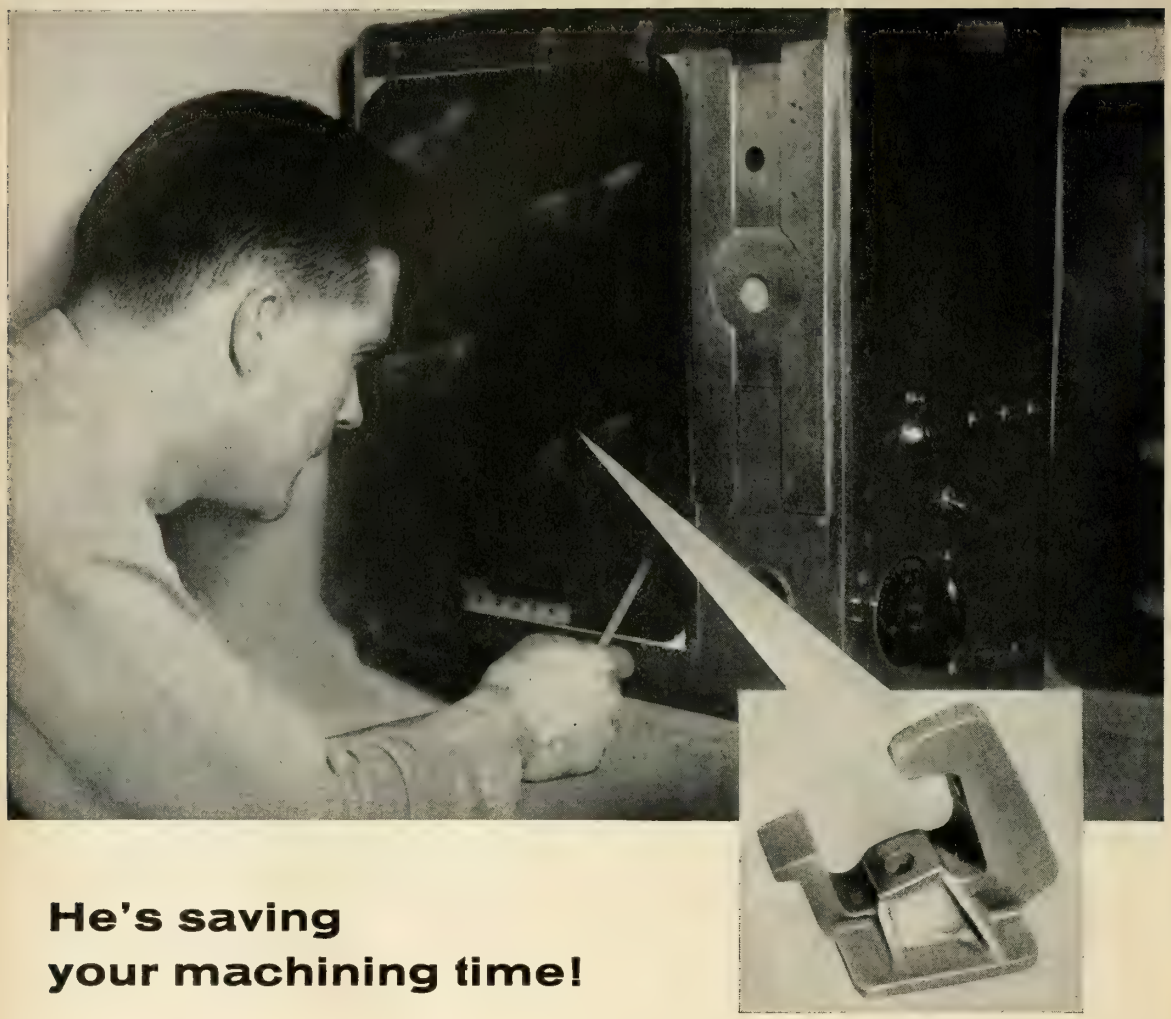
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this issue: Missile Components and Subsystems

news and trends

Navy Unveils *Bullpup* at El Centro 49
Congressmen Learn About Space 52
Missile Meet Set for June 4-6 52
Soviet Reveals IGY Instruments, Vehicles 61
Missiles in the News 62

special features

Most Missile Money Goes to Subsystems
m/r staff report 74
Components in Production 76
Diesel Units Power Ground Support
by J. H. Ashton 78
New Missile Products
m/r survey by Frank McGuire 80
Selling Subsytems
by Seabrook Hull 89
Atlas Testing 90
Congressman John E. Moss—Our Confusing Security Program 93
Subsystem Contractor Breakdown 102
m/r exclusive
NACA Probes Fluorine Uses
by Alfred J. Zaehringer 104
Spatiography: Geography for Space
by Dr. Hurbertus Strughold 106
Air on Mars—Yes, But 111
Thor Gimbal System 113
Profile: Robert P. Haviland
by Erica Cromley 121
Pump Cuts Weight, Raises Power Ratio
by William Patterson 127
Red *Sputniks* For War?
by Dr. Raymond L. Garthoff 134
Vanguard Engine
by Louis Michelson 139
Alamogordo—Where Missiles Bloom
by Alfred J. Zaehringer, Norman L. Baker 155
Vacuum Jacket Lines Save Fuel 169
TV Guidance 200

next issue: Missile Optics and Telemetry

cover picture:



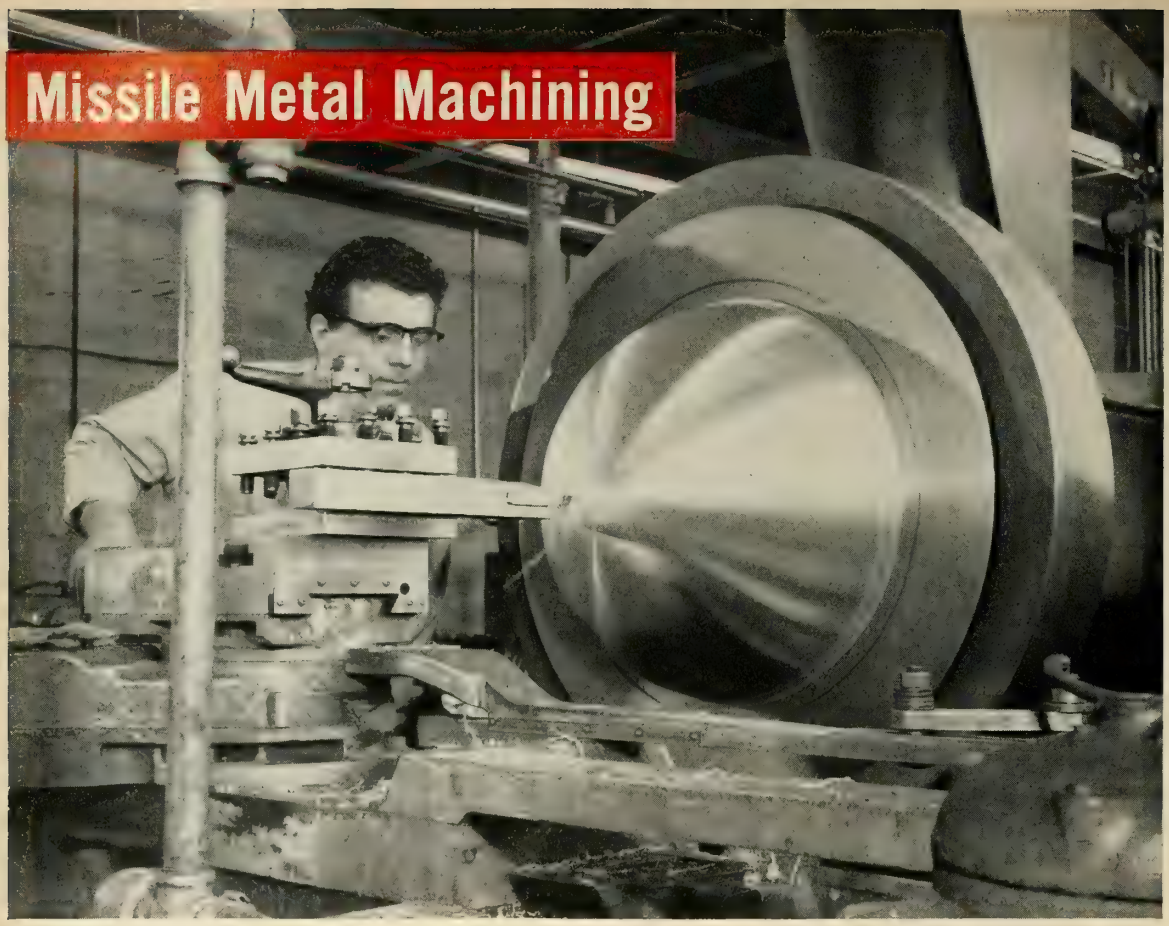
Representing the tremendous amount of ground support equipment necessary for testing ICBMs, the above photograph shows an Atlas *set up for static firing of its main and vernier engines at Convair-Astronautics' Sycamore Canyon facility in California. Independent ground power units, such as Caterpillar Tractor Co.'s diesel electric generator (at left), propellant transfer facilities, and transportable vans for electronic equipment, are all big procurement subsystem items. (See Page 78.)*

columns

Missile Business 34
West Coast Industry 41
Washington Trends 47
Space Medicine 133
Missile Age 148
Propulsion Engineering .. 152
World Astronautics 171
Soviet Affairs 190

departments

Editorial 9
When and Where 13
Letters 15
Contract Report 23
Missile Miscellany 167
Missile People 173
Moscow Briefs 180
Book Reviews 192



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Thank you, Dr. Hagen!

The missile business is not a mass production industry. Missiles for tomorrow aren't skinned, ribbed, and riveted like flying machines —they are machined, welded, and heat treated, and although we spend billions for such missiles, most of the money goes for painstaking research, for prototype development—and for quality. This is accomplished—not by machines—but by the men behind the machines, and by the brains, vigor and confidence of these men.

Dr. John P. Hagen, for one, has set an example through public appearances, through testimony before Congress, and through eager work in his own shop. He has shown what is needed to push the American missile business forward. Thank you, Dr. Hagen! Thank you for being yourself.

Men like Dr. Hagen certainly do not necessarily come from the aircraft industry—or from the automobile industry—or from an Army arsenal or a Navy shipyard. They come from all walks of the great American industry—to make up a special segment: the $4 billion missile business.

In rocketry, more than in any other science, there is a definite requirement for an individualistic approach to all problems. You don't build rockets—like guns or aircraft—by the book.

The successful completion of a rocket system program requires a mass of minute, nerve-wracking detail work. Yet, the essence of rocket progress is foresight and common sense, exhibited by individuals without any fear or reluctance to back a program all the way, with their personality, optimism and spirit.

Our confused rocket programs need this kind of push. Technological progress in this country—despite our great arsenal of scientific talent —is suffering from lack of individualism, lack of encouragement for young engineers to stick their necks out, and lack of individual recognition.

Let us not fool ourselves and think for a moment that we shall catch up with Russia in rocketry by asking our able missile men to keep their mouths shut, to make them sterile to individualistic thinking and to common sense. What's happening to the great American democracy? Is individualism on the wane in this country? If so, missile and rocket progress most certainly will go down with it.

The individualistic approaches by Dr. Wernher von Braun, Maj. Gen. B. A. Schriever, Maj. Gen. John B. Medaris, Rear Admiral Raborn and Dr. John P. Hagen—the opinions of whom have been fairly unsuppressed until now—have at least carried our missile programs forward to some degree.

But we need thousands of such men, engineers and scientists who—like Dr. John P. Hagen will press their teams on to perform a remarkable job through personal sacrifice and personal interest—through completely uninhibited thinking and a truly democratic individualistic approach.

Dr. Hagen could not have put his satellites up alone. His success is based on teamwork. So is von Braun's and Admiral Raborn's and General Schriever's. Teamwork alone, however, would have resulted in little or nothing; excellent leadership is a must in this business.

We have done fairly well in recent years thanks to this handful of individualists and their personal sacrifices. But we need to do better—we need many, many more of them—people with individualistic courage and skill, applied right across the board. We must encourage our young scientists and engineers and inventors to exhibit the same kind of guts and go—and not kill the drive in them.



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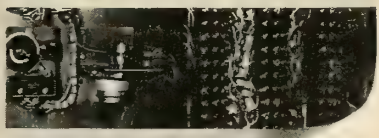
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when and where

MAY

American Society of Tool Engineers, Second Annual Technical Meeting, New York, N.Y., May 1-8.

National Flight Test Instrumentation Symposium, Instrument Society of America, Park Sheraton Hotel, New York, N.Y., May 4-7.

Professional Group on Microwave Theory and Techniques, National Symposium, Stanford University, Palo Alto, Calif., May 5-7.

IRE, ACM, AIEE, Western Joint Computer Conference, Los Angeles, Calif., May 6-9.

IRE, National Conference on Aeronautical Electronics, Biltmore Hotel, Dayton, Ohio, May 12-14.

IAS, National Midwestern Meeting on Guided Missiles, Hotel Chase, St. Louis, Mo., May 12-14.

3rd Production Exhibitions Conference, Institute of Production Engineers, London, England, May 12-21.

Society-Experimental Stress Analysis 1958 National Spring Meeting, Manger Hotel, Cleveland, Ohio, May 14-16.

Armed Forces Day Dinner, Sheraton-Park Hotel, Washington, D.C., May 16. Observances in various cities, May 10-18.

17th Annual National Conference, Society of Aeronautical Weight Engineers, Inc., Belmont Plaza Hotel, New York, N.Y., May 19-22.

AIA, Board of Governors Meeting, Williamsburg, Va., May 21-23.

Aviation Writers Association Annual Convention, Shamrock Hilton Hotel, Houston, Texas, May 25-31.

JUNE

IAS, AIEE, ISA, National Telemetering Conference, Lord Baltimore Hotel, Baltimore, Md., June 2-4.

First National Guided Missile Industry Conference, Mayflower Hotel, Washington, D.C., June 4-6 (Robert H. Goddard Memorial Dinner, June 6).

Armed Forces Communications and Electronics Association Convention, Sheraton-Carlton Hotel, Washington, D.C., June 4-6.

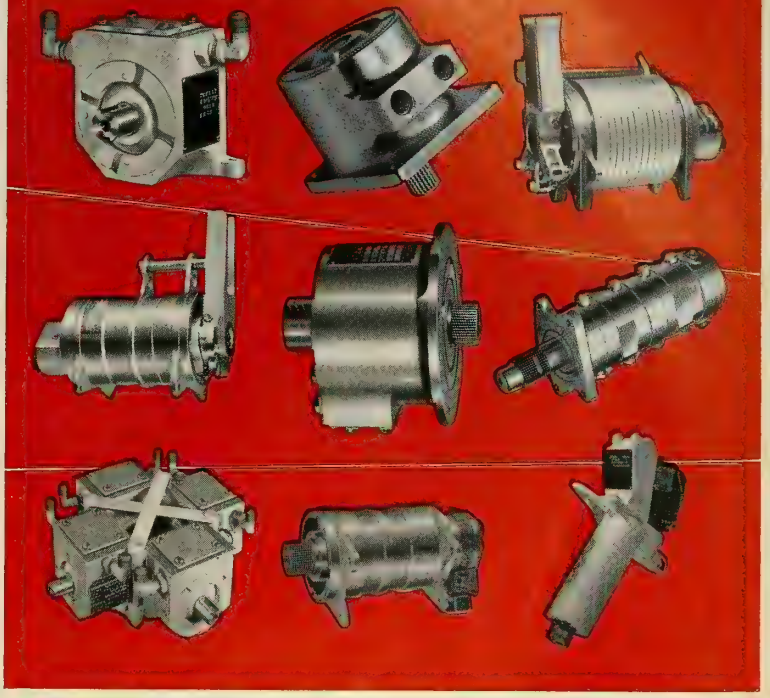
IRE Second National Symposium on Production Techniques, Hotel New Yorker, New York, N.Y., June 5-6.

American Rocket Society, Semiannual Meeting, Hotel Statler, Los Angeles, Calif., June 8-11.

ASME Semiannual Meeting, Statler Hotel, Detroit, Mich., June 15-19.

Military Electronics, National Convention, Sheraton Park Hotel, Washington, D.C., June 16-18.

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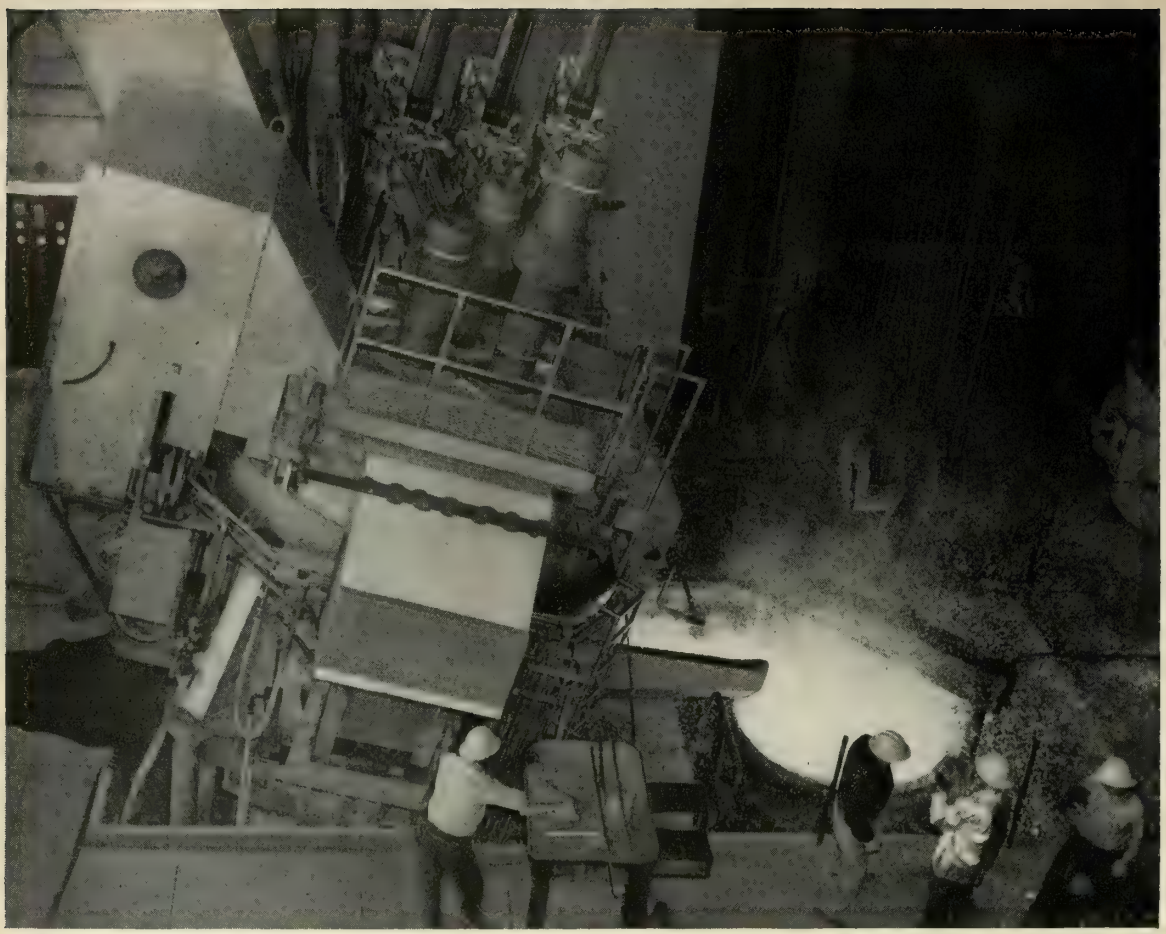
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Life Span 10 Years

To the Editor:

We were quite pleased with the handling of our article on recoverable booster studies to cut manned space flight cost in the April issue. However, we were somewhat concerned with regard to a couple of typographical errors which occurred.

Of particular concern to us was the one giving operational life span of a given model as 100 years, which should, of course, have been 10 years. We believe that most of your readers will recognize this as a typographical error, but are concerned with the possibility that some might not. The only other error was the interchange of numbers on Figures 1 and 2.

D. C. Romick
Weapons Systems, Department 460
Goodyear Aircraft Corporation

GS Group Needed?

To the Editor:

After reading the Ground Support Equipment issue of m/r for January, 1958, I began to wonder why an organization of GSE Engineers had never been formed.

With the increase in importance and in government expenditures on GSE for advanced weapons systems, it would seem that a group of this sort could do much in helping to standardize techniques and methods, and to disseminate information among manufacturers who would not normally come into contact with each other.

I would welcome any comments on this subject from m/r readers who may or may not be actively concerned with GSE.

Walter E. Bailey
Bell Aircraft Corp.
Buffalo 5, N.Y.

An excellent suggestion—we too, would welcome any comments from our readers—Ed.

Hi Temp Omission

To the Editor:

We have read with great interest and enthusiasm the very extensive review of missiles in the March issue. It was an outstanding piece of work.

However, there was one omission which is most important to us: in the materials section no mention was made of the very extensive line of high-temperature materials of construction made by Haveg Industries, Inc., and Reinhold Engineering and Plastics Co., Inc., for use in blast tubes, nozzles, jet vanes, jetevaters, insulation, adapters, and the like.

These materials, known under the proprietary names of Missileon, Mercuron, Planeton, Rocketon, Orbiton, Asteron, Galaxon, etc., are now standard in 18 different missile programs, many of which are in production.

We are also working in nose cone and re-entry areas and have equipment in place to make any sizes up to 12 feet in diameter. We are also doing an extensive amount of both prototype and production work at both Haveg and Reinhold facilities.

We are also manufacturing a wide variety of high-temperature wire and cable for the electronic phases of the industry. This includes Teflon coated wire and wires coated with pure silica fiber.

Haveg materials have functioned satisfactorily when subjected to products of combustion having flame temperatures as high as 5800°F. Past experience indicates that we should be in a position to cope with all high-temperature insulating problems associated with the missile field.

John H. Lux
President
Haveg Industries, Inc.
Wilmington 8, Del.

GE Did its Job

To the Editor:

I have recently read an article in the March '58 issue of m/r. describing the General Electric engine on the *Vanguard* program.

I have been gathering certain facts from the people in my organization on the subject of engine performance and thought it would be worthwhile to present a summary of this information to you. Your story mentioned that, according to one Pentagon source, the Hermes engine proved to be—among other things—too rusted for use in the first-stage vehicle; GE has to design a new first stage engine for the application of the Vanguard.

In my experience, no one engine has ever filled the bill for another application without design changes. This was exactly the case of the Vanguard engine designed by the GE Co. The experience gained during the Hermes Program was directly applicable and has largely contributed to a compressed development time.

MISSILES and ROCKETS continues: "As for the *Vanguard,* in spite of official reasons released to the public, the general opinion is that it has not



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*Patents Pending

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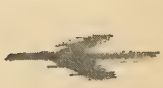
Here's the Army's answer to a major problem in U. S. defense. Hawk, recently-revealed missile, hunts and destroys invading aircraft *even at tree-top altitudes!*

Raytheon radars of unique design give Hawk its amazing low-level ability in the blind zone of conventional radars.

This aptly named 16-foot missile can be launched from fixed installations for the defense of U. S. cities. Highly mobile, Hawk can also travel with fast-moving land forces of the Army and Marine Corps, or be transported by helicopter or plane.

Raytheon, with more than a decade of pioneering in guided missiles, is prime contractor for the complete Hawk weapon system.





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Missiles/Rockets—and Steel

Lukens Steel Company, with the world's largest capacity for producing spun and pressed "head" shapes, is forming nose cone blanks for the Air Force's Thor and Atlas, as well as other vital rocket and missile parts.



In the past, the men who carried the major burden in developing weapons systems had little need to know about the techniques for forming steel plate and other heavy materials. But now such problems are a vital part of our missile age, and steel companies having the necessary facilities and know-how are playing an important role in missile weapon systems development.

That is why, for example, the nose cone blanks for the Air Force's Atlas and Thor ballistic missiles are being formed by Lukens Steel Company on one of the most unusual facilities in the steel industry—a mammoth four-post hydraulic press capable of exerting a force of up to 4 million pounds. Lukens is performing this work for General Electric Company's Missile and Ordnance Systems Department, prime contractor for the ballistic nose cone.

Over Seventy-Five Years of Experience

Lukens produces its own steel and possesses the world's largest capacity for spinning and pressing the dome shapes known to the steel industry as "heads." In 1880, Lukens pioneered a machine which produced steel heads by means of a spinning or flanging operation—similar in working principle to a potter's wheel. Since that time, this process has undergone constant refinement. Today, supplemented by a line of presses for volume production items, Lukens facilities offer the widest range of types, sizes and qualities of head shapes available anywhere. The versatile flanging machines can spin heads from 12 inches to 21 feet in diameter and from 3/16 inch to 6½ inches in thickness. Huge hydraulic presses, like the one used for the Air Force program, have turned out the largest heads pressed—hemispheres nearly 7 inches thick. These same machines can press ultra-high strength steel in sheet gages to the order of 180,000 psi tensile material.

The metals used in head production range from the various steels and clad steels rolled on Lukens own mills to such materials as aluminum, copper, nickel, stainless steel, Monel, Inconel, titanium and Hastelloy.

For Missile Production and Handling

As the long-time leader in producing heads, Lukens has served many fields of industry—the most recent being the nation's missile producers. The areas connected with missile production and handling in which head shapes are playing a growing role are often areas in which Lukens heads have been employed in similar manner for many years. The storage of fuels and oxidants at test and launching sites requires tanks with heads at each end. Formed from corrosion-resistant Lukens clad steels, heads have long been supplied to the chemical industry for precisely such application. Solid rocket engine casings utilize dome ends which must withstand enormous pressures. Both the petroleum and chemical industries use steel heads for vessels in which liquids are contained under high pressures. To meet the demands of absolute safety, Lukens has spent years working with the latest high-strength steels and perfecting the required precision. This skill and knowledge is immediately available to missile engineers to fulfill their own design requirements.



On this mammoth hydraulic press capable of exerting up to 4 million pounds pressure, Lukens Steel Company has formed nose cone blanks for the Air Force's Atlas and Thor ballistic missiles.

Nose cones, fuel tanks, and rocket casings are, of course, only a few of the literally hundreds of uses to which heads can be put. In using them as examples our point has simply been this: wherever a metal dome shape can be utilized in the missile industry, experienced craftsmen can provide it—swiftly, accurately, with a quality achieved through long experience.

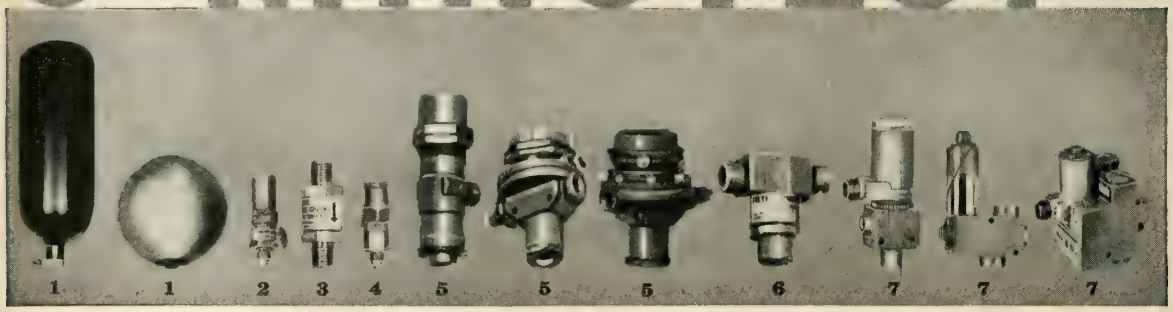
Send for More Information

Lukens specialized knowledge of head uses, sizes, types and qualities is immediately available. For assistance with specification or production problems, write to Manager, Marketing Service, Lukens Steel Company, 150 Lukens Building, Coatesville, Pennsylvania.

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flown mainly because of an inadequate first-stage engine."

The facts are that GE delivered all engines to the Martin Corp., and that all engines passed acceptance tests without failure. As a matter of facts, qualification tests were successfully completed without waivers.

Your next paragraph mentioned the cause of the *Vanguard* failure, after the missile attained an altitude of 96".

Detailed investigation by qualified personnel revealed that raw fuel leaked out of propellant pipes upstream of the GE engine and that neither design, maintenance, or operational deficiencies of the GE engine contributed to this failure.

Finally, your statement "The *Vanguard* finally struggled into the sky, and the marginal thrust-to-weight first-stage engine got the *Vanguard* off the ground" are matters no engine contractor has control over. Engines are built to specifications of thrust ratings, specific and total impulses which have to lift a given weight into the air. The specifications given to the GE Co. were met in all aspects.

Richard F. Gompertz
Malta Test Station
Ballston Spa, NY

Wrong Picture

To the Editor:

The nice editorial treatment you gave to the story on DuKane Corp'. development of a new satellite transmitter (April, page 152) was extremely gratifying both to DuKane and to us, as DuKane's public relations counsel. We have already heard from readers of m/r who want more information, even though the issue has been out only a few days.



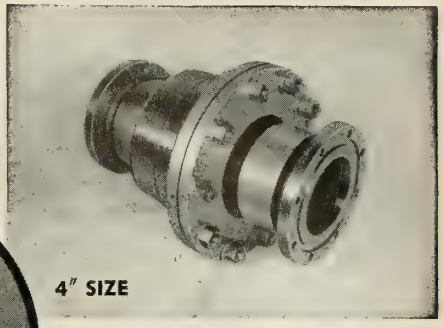
Apparently, however, someone mixed up DuKane's photographs with

BARCO FLEXIBLE JOINTS

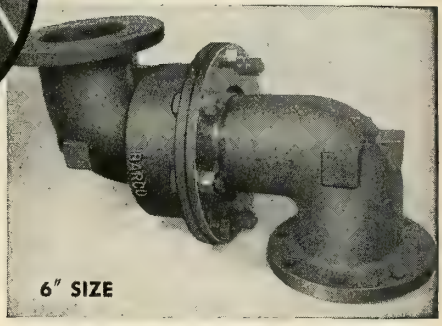
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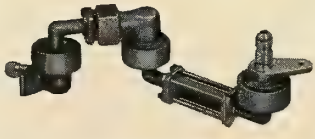
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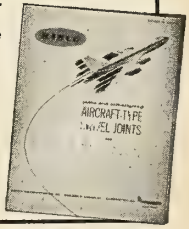
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AIRCRAFT DIVISION

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someone else's, for the photos which appeared in connection with the satellite transmitter story were not those originally supplied, and bore no relationship to the text of the story or the picture captions as published.

These slip-ups occasionally occur, I know, in the pressure of getting out a periodical publication. In fairness to readers of m/r who have an active interest in the subject, however, I presume you'll want to print a correction of this one, and possibly include the right pictures in your next issue.

Robert E. Kilbride
The John Marshall Ziv Organization
75 East Wacker Drive
Chicago 1, Ill.

For correct photo, see p. 19—Ed.

Recommended Reading

To the Editor:

We read, with great interest, your excellent article entitled "1958 Missile Materials Review" in the March issue. In this regard, we believe that you will be interested in the enclosed report which has just been published by the AIA under the auspices of our Aircraft Research and Testing Committee and Manufacturing Committee.

This report is prepared annually to provide suitable information for the guidance of research and development programs conducted by the Department of Defense, the aircraft and missile industry, and materials producers. Copies are available upon request to this office. Your comments will be welcomed.

H. D. Moran
Technical Service
Aircraft Industries Association
Los Angeles 36, Calif.

We heartily recommend this report to our readers who are engaged in the nation's missile research and development programs. This report briefly, but concisely, surveys the requirements for materials, processes, testing and manufacturing methods forecast for the next five- and ten-year periods . . . Ed.

Earlier *Explorers*

To the Editor:

In view of the recent feats of the Jupiter-C rockets that carried *Explorer* I, II, and III into space, the following may be of interest:

The original *Explorer* I was, in its day, the largest free-flight balloon ever built. On July 28, 1934, after being filled with hydrogen, it was released over the Dakotas carrying a crew of three Army Air Corps officers. The balloon rose to an altitude of 11½ miles before it suddenly tore open across the bottom and carried its crew to an altitude of one-half mile before they jumped to safety.

About a year later, *Explorer* II, an even larger free-flight balloon, was ready for another attempt to send instruments and observers to the top of the earth's atmosphere. It rose to an officially-recognized height of 72,395 feet, carrying two of the previous crew members and 64 scientific instruments. These flights, jointly sponsored by the National Geographic Society and the Army, yielded invaluable data on the stratosphere and other phenomena. The two crew members, Capts. Albert W. Stevens and Orvil A. Anderson, spent one hour and forty minutes above seventy-thousand feet.

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National Geographic Society



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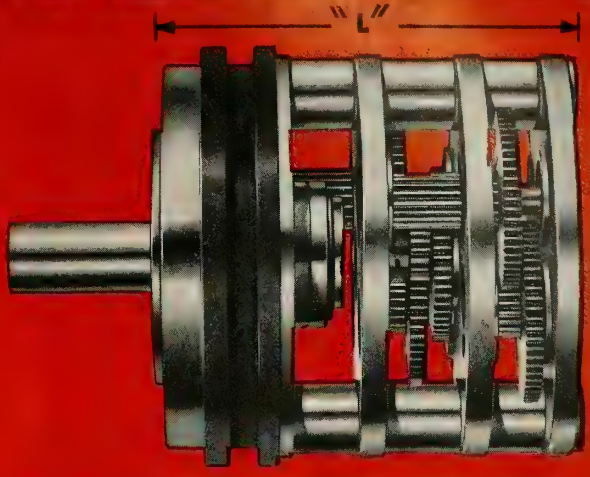
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Pinion Data: Number of Teeth	12		13		13		15		15	
Diametral Pitch	120		120		120		96		96	
Pressure Angle	20°		20°		20°		20°		20°	
Pitch Diameter	.1050" +.0 −.0005		.1083" +.0 −.0005		.1083" +.0 −.0005		.1562" +.0 −.0005		.1562" +.0 −.0005	
Gear Ratio to Length "L"	Ratio	"L"	Ratio		"L"	Ratio	Ratio	"L"	Ratio	
	17	0.750	31		0.781	36	40	0.812	60	
	42	0.812	93		0.954	108	140	1.000	240	
	104	1.008	280		1.054	324	490	1.100	960	
	253	1.070	840		1.116	972	1715	1.162	3840	
	615	1.204	2521		1.266	2916	6000	1.328	15,360	
	1494	1.347	7565		1.409	8748	21,000	1.487	61,440	
	3629	1.421	22,696		1.500	26,244	73,500	1.600	245,760	
Moment of Inertia GM CM²	.01		.018		.02		.05		.08	
Maximum Running Torque in. oz.	15		15		20		25		25	
Maximum Stall Torque in. oz.	35		35		40		50		50	
Breakdown Torque in. oz.	.01		.01		.012		.015		.018	
Backlash maximum	30′		30′		30′		30′		30′	

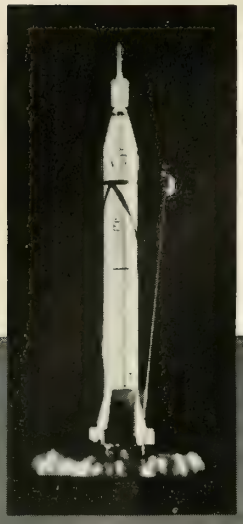
Gear Tolerances: Precision Class 2 AGMA 236.02. *Bearings:* Stainless Steel ABEC Class 5 or better. *Shaft Radial Play:* .002"/inch length max. with 4 ounce gage load. *Shaft End Play:* .002" max. with 1 pound gage load. Friction Slip Clutch available on request. Designed to meet applicable paragraphs of MIL-E-5272.

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World Circling Explorer 1 is Tipped with Republic Stainless Steel



LAUNCHING OF JUPITER-C MISSILE and "Explorer I" Satellite from Cape Canaveral, Florida, 10:48 PM, EST, January 31, 1958.

"EXPLORER I" IS POSITIONED on spin launcher. The satellite is spin-stabilized in much the same manner as a rifle bullet. Rotational spin of more than 700 RPM was started on the ground before the satellite was launched. The striped area at the top of the Explorer indicates the nose cone fabricated from Republic ENDURO Stainless Steel, Type 430.

Official U.S. Army Photographs



Vital instruments in the nose section of the U. S. Army satellite, "Explorer I", are protected by a cone of ENDURO® Stainless Steel produced by Republic. The nose cone was fabricated from Type 430 by The Lodge and Shipley Company, Cincinnati, Ohio using the Floturn Process.

Type 430 is highly ductile. It is readily formed into desired shapes by cold-forming, drawing, and bending operations. It provides low thermal expansion and is highly resistant to atmospheric corrosion, erosion, and oxidation at high temperatures.

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contract report

Trends

Don't be dismayed at the raft of contracts being placed now through fiscal year 1958 (ending June 30), and the fact that you don't appear to be getting your share. A considerable share of the contracts to be negotiated and actually signed during these last two months have already been arranged in advance by contract letters or letters of intent. A large percentage of funds have already been committed this way, due to the fact that it was physically impossible to negotiate contracts at the rate that requirements called for them.

In this connection, obligation of Defense Department funds for major procurement and production hit a two year high of $2.4-billion during the month of March—with AF obligating $1.7-billion; Navy, $400-million; and Army, $300-million. This brings the total for the January-March quarter to $5.4-billion.

Cooperation between Convair-Astronautics division of General Dynamics and AVCO Manufacturing Corp.'s AVCO Research Laboratory on a minimal manned satellite may be a significant sign of things to come. Space flight proposals are one thing. Space flight performance is another. It's a very expensive proposition, and money is a function of effort—scientific, technological and industrial.

To do the space flight jobs in the short time allowed by Soviet competition will require massive effort. This, in turn, means large industrial capabilities devoted to this one subject. Thus, it may be natural to expect project mergers among two or more large corporations. This means that it's more important than ever for you to cement your relations with procurement officers of some of the larger companies in the field.

Pentagon reorganization—No matter whose plan gets the nod—it will not have any immediate effect on contract procedures—at least, not directly. Ultimately, it may have a major impact on which Service gets the most money; and on how much information is or is not made available to contractors. Greater centralization of power in the Secretary of Defense, as proposed by the President, could make it easier for one ambitious Service to grab the lion's share of the funds.

The reason for this is—the plan will mean that fewer people will have to be sold in order for any one Service to get its way, or even to place one of its own ardent proponents in the key spot. This is one of the worries of House Armed Services Committee Chairman Carl Vinson. Another worry is that centralization of all military information services under one absolute czar will mean more censorship than exists even now—not only for the press but for industry as well. It could mean, for example, that you might have to have a "need to know if you need to know . . ."

Here and there: Defense Department has abolished its Research and Engineering Coordinating Committee on Guided Missiles, saying it had served its purpose . . . Navy's asking for $44.2-million for *Talos* in fiscal year 1959, up from $27.6-million in 1958 . . . Army's letting of *Pershing* prime systems contract to The Martin Company means anyone wanting business on this project should work on Martin's Orlando division. . . . Anyone with ideas about really large thin-wall casings should get in touch with Thiokol Chemical Corp. They are already statically firing solid propellant motors 10 feet in diameter by 25-to-30 feet long.

Awards

By Navy: Philco Corp., received $15 million for production of Sidewinder guided missiles. Light Military Electronic Equipment Department of GE Electric Co. received $10 million for production of Sidewinder guided missiles.

By Navy Purchasing Office: Minneapolis-Honeywell Regulator Co., Davies Laboratories Div., received $70,240 for magnetic tape loop analysis system.

By Navy, Bureau of Ordnance: The New Mexico State College was awarded $152,366 for eighty assembled POGO-HI targets. Westinghouse Electric Corp. received $132,000 for facilities to produce *Polaris* launching system. General Electric Co., received $163,-409 for studies leading to the development of ultra-high steels. Vitro Laboratories, Div. of Vitro Corp., received $107,155 for engineering to integrate components of the Terrier land weapon system.

By Navy, Bureau of Ships: Norden-Ketay Corp., Instrument and Systems Div., received $1,119,860 for various switchboards.

By Navy, Office of Naval Research: Materials Research Corp. received $25,500 for research on structural changes of age-hardening processes in binary alloys. Mass. Institute of Technology received $25,000 for research on thermoaeroelastic modeling. University of California received $146,845 for research on the basic factors affecting the strength of metals. Arthur D. Little, Inc., received $65,000 for a study to determine a basis for the decision as to proper level of support of fundamental research. Cooper Development Corp. received $185,758 for research involving measuring portions of the electromagnetic spectrum during a total solar eclipse.

By Your District Public Works Officer: McDonough Construction Co. of Florida, received $763,376 for Azusa radar facility at Eleuthera AFB. McDonough Construction Co. of Florida received $273,833 for radar facility at San Salvador, Mayaguana and Grand Turk Islands, British West Indies.

By U.S. Air Force: General Electric Company's Aircraft Gas Turbine Division received $17-million for an advanced product improvement program on the J79 jet engine.

BY AFFTC, Air Research and Development Command: P. J. Walker Co. was awarded $318,924 for construction of X-15 test facility. Petersen Construction Corp. received $53,358 for mechanical and electrical system for support of 10000 PSI nitrogen system.

By AFMDC, Air Research and Development Command: Stanford Research Institute was awarded $90,468 for study of sled slipper wear problems. Remington Rand Univac received $94,586 for uniservo tape recorder and play back units and spare parts.

HQ AFMTC Air Research and Development Command: Collins Radio Co. received $187,-600 for modification kits for AN/FRW-2 transmitter. Missileonics, Inc. received $69-656 for station, mobile and interference analysis. Westvaco Chlor-Alkali Division of Food Machinery and Chemical Corp. was awarded $37,873 for rocket propellant. Midwestern Instruments received $38,565 for recorders and galvanometers. Dynatronics, Inc. received $52,035 for 200-volt D.C. power equipment. Coleman Engineering Co., Inc. received $28,014 for gaertner digitizing kit. General Dynamics Corp. received $102,716 for test equipment.

By HQ Dayton Air Force Depot: Raytheon Mfg. Co., Government Relations Division, received $1,108,000 for countermeasures sets. **By HQ Rome Air Force Depot:** Flight Research, Inc. received $35,764 for flight research multidata, synchronous motion picture camera.

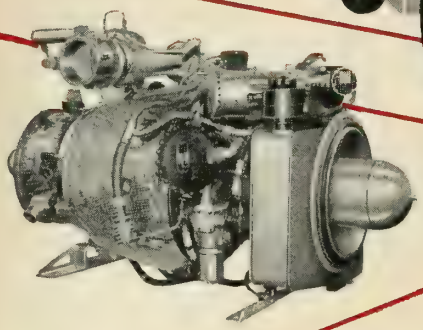
By HQ AFOSR: The Board of Trustees of the **Leland Stanford Jr. University** received $90,000 for research on "microwave solar

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C.A.E. gas turbine models—the J69-T-9, the J69-T-2, and the J69-T-19A are being built for Cessna's T-37A twin jet trainer, Temco's TT-1 Navy jet trainer, the Beech jet Mentor trainer, and the Ryan Q-2A Fire Bee target drone.

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. . . contracts

The Kentucky Research Foundation received $26,136 for research on "chemistry of N-Sulfinyl Amines." **Massachusetts General Hospital** received $100,000 for research on "Study of Behavior and Performance." **Purdue Research Foundation** received $27,500 for research and reports concerning "The Reactions of Amident Anions." **Polytechnic Institute of Brooklyn** received $33,333 for research on "Electron Flow in Plasmas and High Density Bemas." **Stanford Research Institute** received $43,339 for research on "Luminescence of Solids Produced by Surface recombination of Atoms." **Giannini Research Laboratory** received $34,887 for studies on ferromagnetic rare earth systems. **Alfred University** received $29,918 for a study of the correlation between the defect solid state and catalysis. **The University of North Carolina** received $25,566 for research on "Metal Ion Interaction with 'Chelons'". **Bolt, Beranek and Newman, Inc.** received $58,505 for research and reports concerning "Organizational Characteristics of Man-Machine Systems." The Trustees of **Columbia University** received $47,008 for research on "Chemical Bond Energies." **Rutgers State University** received $36,183 for research on a study of "Properties of Matter by Means of Nuclear Magnetic Resonance Techniques." The Regents of the **University of Minnesota** received $56,000 for research on the study of "Natural and Induced Spectra of Some Ferrites." **Kentucky Research Foundation** received $27,910 for research on the electrical and liquid-solid transformation properties of systems of the group Va and VIa elements. **Reaction Motors, Inc.** received $44,332 for research on the influence of ions on rocket combustion. **The University of Pittsburgh** received $40,300 for research on antiferromagnetic resonance, paramagnetic resonance in phophors, foreign atoms in silver halides and nuclear resonance. **Giannini Research Laboratory received** $98,450 for study of plasma jets; $97,627 for investigation of electric thrust devices. **Aerojet-General Corp.** received $48,056 for research on "Kinetics of Solid Phase Reactions." **New York University** was awarded $25,755 for research on hydrodynamic equations for a free radical flame. **Brown University** received $33,275 for research on "Theoretical Study of Problems of Compressible Flow." **The University of Chicago** received $118,950 for research on "Nuclear Interactions in Cosmic Radiation." **Giannini Research Laboratory** received $98,025 for basic study of energy exchange process between an electric arc and a gas flow. **Allied Research Associates, Inc.** received $39,958 for research and reports concerning "Melting and Aerodynamic Ablation of Metals."

By HQ ARDC, Cambridge Research Center: Aerojet-General Corp., $387,730 for aerobee rocket. The Ramo-Wooldridge Corp. received $29,302 for research in the study of infrared sky backgrounds by techniques of space filtering. Geo-Science Inc. received $94,710 for research in the study of air glow and atmospheric reactions. TRG, Inc. received $29,940 for investigation of applied problems in electromagnetic radiation.

By Commander, HQ AMC, Wright-Patterson AFB: Boeing Airplane Co., was awarded $675,327 for materials equipment to design, pilot produce, test, and evaluate titanium castings suitable for use in aircraft construction. AC Spark Plug Div., General Motors Corp. received $84,634 for bomb-rocket set-gun sighting.

By San Antonio R&D Procurement office, Air Research and Development Command: The Trustees of Tufts College were awarded $25,875 for research on the effects of environmental and nutritional factors on intermediary metabolism.

By Cleveland Ordnance District: Cyril Bath Co., was awarded $49,828 to contract special tooling, frames and rings for guided missiles.

By Philadelphia Ordnance District: Western Electric Company, N.Y. received several contracts totalling $555,281. Western Electric Company (N.C.) received $539,969 for *Nike* spare parts and components. Air Products, Inc. received $584,325 for liquid oxygen semi-trailer. The Research Institute of Temple University received $161,895 for aerodynamic heating tests. The Corporation for Economic & Industrial Research received $66,500 for type 704 digital computer time. Western Electric Co., Inc. received 9 contracts totalling $1,032,612 for *Nike* spare parts and components.

By U.S. Army Ordnance District: Southwest



WITH NITROGEN TETROXIDE

. . . Requires no refrigeration . . . Easier to store than liquid oxygen

Performance of Nitrogen Tetroxide as an oxidizer for many fuels is comparable to that of liquid oxygen. In convenience it is far superior to liquid oxygen.

N_2O_4 can be shipped easily and stored indefinitely without refrigeration in ordinary carbon steel containers. It is a dense, mobile liquid that is noncorrosive if kept dry. The quantity of oxygen contained per unit volume of N_2O_4 is 1.01 Kg/liter at 20°C.

N_2O_4 is available in tonnage quantities from Allied's Hopewell, Virginia plant. For experimental purposes, N_2O_4 is available in 125 lb. cylinders and 2000 lb. containers. Write for technical data, and information on prices and delivery.

N_2O_4 Oxidant for liquid rocket propellants

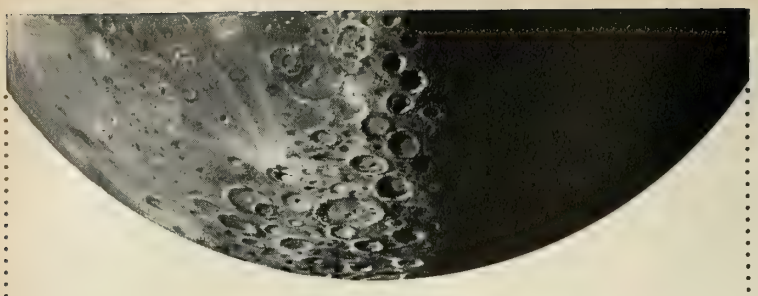
Molecular weight	92.02
Boiling Point	21°C
Freezing Point	−11.3°C
Latent Heat of Vaporization	99 cal/gm @ 21°C
Critical Temp.	158°C
Critical Pressure	99 atm
Specific Heat of Liquid	0.36 cal/gm −10 to 20°C
Density of Liquid	1.45 gm/ml at 20°C
Density of Gas	3.3 gm/liter 21°C, at 1 atm
Vapor Pressure	2 atm at 35°C

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Circle No. 95 on Subscriber Service Card.



A quiz for Rocket Propulsion Engineers

(Time Limit: 10 years)

1. What is the maximum theoretical specific impulse obtainable for a rocket motor with zero combustion volume?

2. What is the basic mechanism involved in jet separation in nozzles, and how can the separation point be predicted as a function of nozzle divergence angle?

3. What is the effect on turbine blade design of a working gas which is still reacting and changing its composition?

4. What are the dynamic interrelations among the various components of a rocket engine, and what control systems will best solve the rocket engine control problems?

5. What is the flame holding mechanism in a rocket motor and how can fundamental understanding of such a mechanism be used to increase reaction ratio?

6. What types of fluid transport systems offer simplicity, efficiency, and light weight (other than the conventional turbopump)?

7. What are some workable methods of translating chemical energy into thrust – other than by the standard combustion at high pressure and then conversion to velocity?

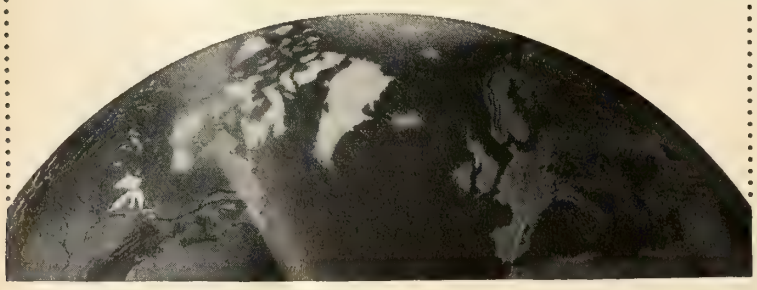
If you would like to work in these areas and have an outstanding technical background, an inquiring mind, and the creative ability to visualize new solutions, possess a M.S. or Ph.D. degree in Physics, Chemistry, M.E., A.E., Ch.E., E.E., or a B.S. degree in the above with a thorough background in applied research, we have a place for you at Rocketdyne.

Please write to Mr. D. E. Jamieson, Engineering Personnel, 6633 Canoga Avenue, Canoga Park, California.

ROCKETDYNE

A DIVISION OF NORTH AMERICAN AVIATION, INC.

BUILDERS OF POWER FOR OUTER SPACE



. . . contracts

Research Institute was awarded $182,500 for basic and applied research in fuels and lubricants. R. G. LeTourneau, Inc. received $84,459 for Corporal system repair parts for United Kingdom program. Ralph M. Parsons Co. received $64,831 for instrumentation for hangar. Douglas Aircraft Co. received $70,848 for repair parts for *Nike* system. Firestone Tire & Rubber Co. received $53,000 for guided missile surface-to-surface. North American Aviation, Inc. received 2 contracts totalling $161,000 for rocket engines. Gilfillan Bros., Inc. received three contracts totalling $124,919 for furnishing repair parts for the *Corporal* missile system.

By Los Angeles Ordnance District, U.S. Army: North American Aviation, Inc. received 3 contract awards ($200,000; $50,000; $120,000) for rocket engines. **Douglas Aircraft Co., Inc.,** received $55,861 for repair parts for *Nike* system. **Gilfillan Bros. Inc.,** was awarded $46,080 for replenishment repair parts for the *Corporal* missile. **North American Aviation Inc.,** received $256,703 for digital computer. **Firestone Tire & Rubber Co.,** was awarded $28,603 for guided missile, surface-to-surface. **Reynolds Industries, Inc.,** received $30,949 for technical equipment. **Douglas Aircraft Co. Inc.,** received $294,521 for *Honest John* improvement program. **Gilfillan Bros., Inc.,** received $44,557 for emergency and blue streak requirements of spare parts for *Corporal* missile system. **Topp Industries, Inc.,** received $135,739 for angle of attack transducers. **Lear Inc.** received $146,-136 for gyroscope. **Reynolds Industries, Inc.,** received $30,949 for technical equipment. **Douglas Aircraft Co. Inc.,** received $294,521 for Honest John improvement program.

Gilfillan Bros. Inc., received $44,557 for emergency and blue streak requirements of spare parts for *Corporal* missile system. **Topp Industries, Inc.,** received $135,739 for angle of attack transducers. **Lear, Inc.** received $146,136 for gyroscope. **Gilfillan Bros. Inc.** received 5 contracts totalling $380,576 for furnishing and delivering of replenishment repair parts for Corporal missile system. **Firestone Tire & Rubber Co.,** received $86,931 for replenishment repair parts for guided missile, Artillery M2, and related ground handling equipment. **Aerophysics Development Corp.,** received $494,000 for reports for drop test of *Jupiter* nose cone, individual and final. **G. M. Giannini & Co. Inc.,** received $60,780 for pressure transmitters.

By New York Ordnance District: Western Electric Co. Inc., received $85,932 for *Nike* spare parts and components. Linde Co. Div. of Union Carbide Corp. received $367,583 for nitrogen converter. Tenney Engineering, Inc. received $47,377 for environmental test installation.

By Army, Chicago Ordnance District: American Machine & Foundry Co., has been awarded $59,910 for thruster supply contract. A. O. Smith Corp. received $80,850 for nitrogen receivers supply contract. Flexonics Corp. received $26,000 for supply contract expansion joints and hose assembly for missile. D. W. Onan & Sons, Inc. received $31,605 for repair parts for launcher rocket.

By Army: The Martin Co., Orlando Fla. received $16 million for production of La-Crosse guided missiles and related equipment. Burroughs Corp. of Detroit received $3,891,027 for production of electronic communications equipment.

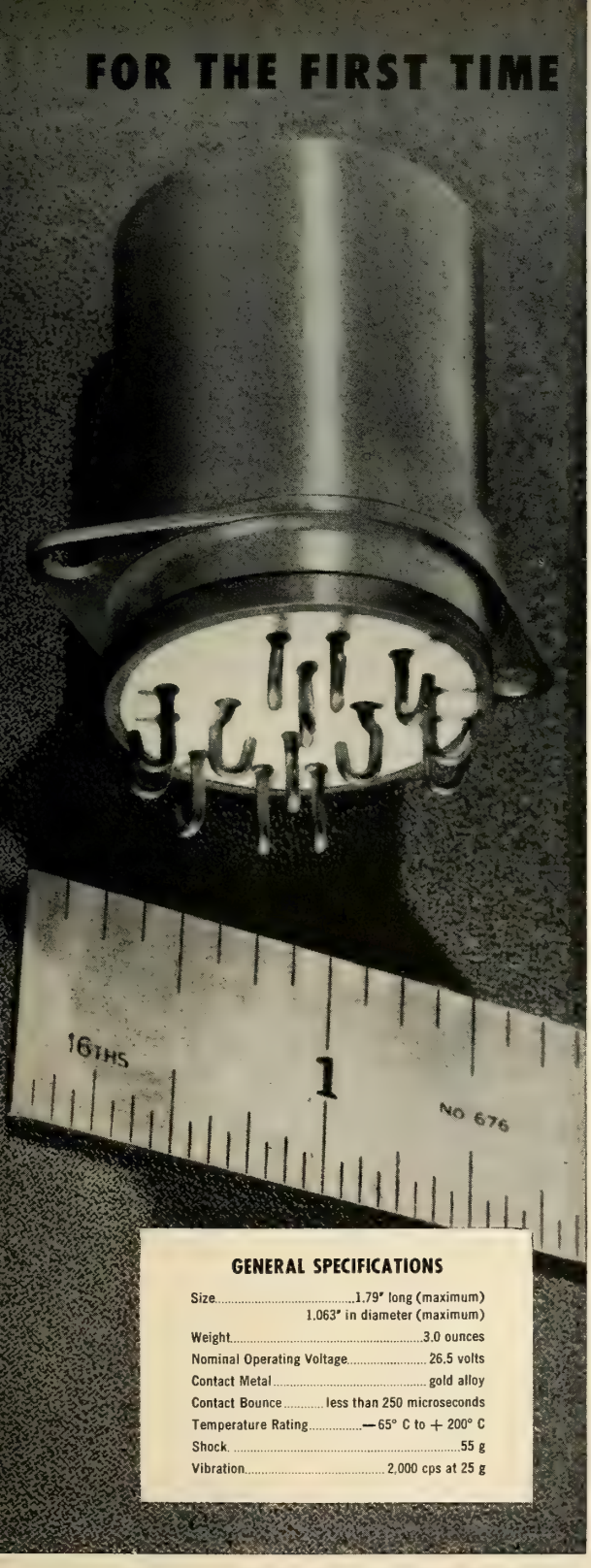
The Martin Company announced that Hallamore Electronics Co., a division of the Siegler Corporation of Anaheim, Calif., has received a $3 million addition to its contract for instrumentation and field test equipment work on the USAF *Titan* Intercontinental Ballistic Missile.

By Purchasing and Contracting Division: The Perkin-Elmer Corp., received $61,960 for infrared rapid scan spectrometer.

By Secondary Items Section, Industrial Division, Redstone Arsenal: The Waco Aircraft Co. received $51,464 for skin assembly.

By Redstone Arsenal, U.S. Army: Linde Co. Div. of Union Carbide Corp., was awarded $117,300 for liquid nitrogen and liquid oxygen. Thiokol Chemical Corp. was awarded $29,025 for development and delivery of XM9E1 Jatos; $35,000 for facilities for development, manufacture & delivery of TX62 rocket engines; $152,407 for design and development of solid propellant vernier engine.

Circle No. 7 on Subscriber Service Card.



a new 4PDT relay to meet all requirements of MIL-R-25018!

Don't compromise with the Class C, Type II, Grade 3 requirements of MS 24114-9, MIL-R-25018. You don't have to any more. Now Union Switch & Signal has a 4PDT, rotary-armature relay designed to meet these specifications *completely*. It is the first of its type to do so. In fact, it *exceeds* some of the rugged requirements.

Here is the kind of performance you can expect from this new relay:

High operating temperature. Even at an ambient temperature of 200° C, this relay gives optimum performance. The use of ceramic material provides consistently high insulation resistance. As a result, you can install this relay closer to engines. You often can use it *without* temperature controlled boxes. Always, you will find it supremely rugged and reliable.

High in shock resistance. This new UNION Relay withstands shock *greater* than 55 g for 11 milliseconds—and continues to operate. In vibration tests, it shows no contact chatter up to 2,000 cycles at an acceleration of 25 g.

New high in contact reliability. Contact reliability of this relay is *six times* that of comparable devices because of its new 2-button, bifurcated contacts. Bifurcation also increases current carrying capacity (each button easily handles a full 2-ampere load) . . . and makes gold alloy contacts practical for both low- and high-level loads.

Contact reliability is enhanced, too, by the ceramic insulation which contains no volatile material to contaminate contacts and by separate hermetic sealing of the magnet coil.

New torsion-type rotary-armature suspension improves resistance to thermal shock . . . increases reliability over the entire temperature range . . . and greatly extends the operating life of this new 4PDT relay. Call or send the coupon for complete information about this and other miniature relays manufactured by Union Switch & Signal.

GENERAL SPECIFICATIONS

Size	1.79" long (maximum) 1.063" in diameter (maximum)
Weight	3.0 ounces
Nominal Operating Voltage	26.5 volts
Contact Metal	gold alloy
Contact Bounce	less than 250 microseconds
Temperature Rating	— 65° C to + 200° C
Shock	55 g
Vibration	2,000 cps at 25 g

COMPLETE FACTS

Union Switch & Signal,
Division of Westinghouse Air Brake Co.
Pittsburgh 18, Pennsylvania

Please send the following:

☐ Complete description of your new 4PDT relay which meets every requirement of MIL-R-25018. ☐ Catalog of other miniature dc and ac relays which you manufacture to MIL-R-25018, MIL-R-6106C, and MIL-R-5757C requirements. ☐ Description of your Digital and Alpha-Numerical Indicators for data display.

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MIDWEST: Burnie L. Weddle, 1347 Pennsylvania St., Indianapolis 2, Ind., MElrose 5-5607
SOUTHWEST: Marshall Morris, 2850A W. Berry, Rm. 14, Fort Worth, Texas, WA 4-8679
NORTHWEST: J. L. Larsen, 5757 Oaklawn Place, Seattle, Wash., MOhawk 9311
CANADIAN PLANT: THE H. I. THOMPSON CO. OF CANADA LTD., 60 Johnston Street, Guelph, Ontario, Telephone: TAylor 2-6630

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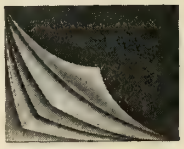
REFRASIL "Pre-Formed" and "Wrap-around" Insulating Blankets are preferred by the majority of aircraft and jet engine manufacturers all over the world!



WRAP-AROUND

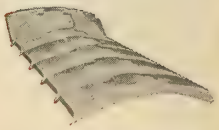


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Removable Insulating Blankets combine top Acoustical and Thermal insulating efficiency with convenient flexibility for ease of installation and removal in jet airliners, cargo and Military Aircraft.

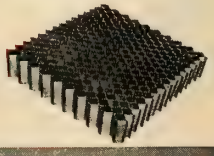
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In Stainless Steel and a variety of other materials. Various thicknesses, core sizes and foil gages can be combined to meet your special requirements.



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. . . contracts

Rohm and Haas Company received $214,800 for research & development of solid propellant rocketry. Consultants and Designers, Inc. received $370,000 for 6100 additional man-hours of engineering services.

By U.S. Army Signal Supply Agency: Armour Research Foundation of Illinois Inst. of Technology was awarded $84,357 for research work pertaining to radar generated interference. **RCA Service Co. Inc.** received $31,916 for installation and operation of radio equipment for propagation studies. **Cook Electric Co.,** received $82,447 for research for *Nike I* electronic parts. **Belock Instrument Corp.,** received $28,654 for investigation Army Signal System interference. **New York University,** College of Engineering, received $209,988 for research to supply technical and secretarial personned for the Advisory Group on Electron Tubes. **Kaysam Corp. of America** received $45,352 for research for investigation of the physical characteristics of balloons and balloon materials. **Dewey and Almy Chemical Co.,** Div. W. R. Grace & Co., received $38,710 for balloon high altitude. **Emerson Research Labs. Div.,** Emerson Radio & Phono. Corp., received $123,067 for millimeter communication equipment. **Hewlet-Packard Co.,** was awarded $115,105 for high frequency oscilloscope. **Dynac, Inc.** received $79,302 for generators. **Philco Corp.** received $25,600 for retma transister. **The James Knights Co.,** received $41,693 for frequency standard, high stability. **Sylvania Electric Products, Inc.** received $90,000 for magnetron, QK-362A, wigh SM connectors. **The Machine & Tool Designing Co.,** received $53,248 for studies of piezolelectric crystals. **Arcs Research & Development Corp.,** received $68,798 for transformers. **Airborne Instruments Laboratory, Inc.,** received $33,680 for hydrogen line receiver. The State Board of Higher Education of **Oregon State College** received $30,926 for research for investigation on Army Weather Observation. **Bendix Aviation Corp.** received $863,668 for wind measuring set. **Armour Research Foundation of Ill.,** Institute of Technology, received $87,656 for research and development of miniature RA cables and connectors.

By U.S. Army Engineer Division: James Farina Corp., received $200,685 for Construction of field unit integration facilities at twelve *Nike* sites. Anderson-Nichols Co., was awarded $80,040 for SAC missile facility, Ethan Allen AFB. The Bridge Construction Corp. received $166,720 for alterations and additions for *Nike* for Loring AFB defense area.

By Army Map Service, Corps of Engineers, U.S. Army: Hal Peterson, DBA International Aerial Mapping Co., was awarded $182,020 for Western U.S.S.R. topographic map compilation.

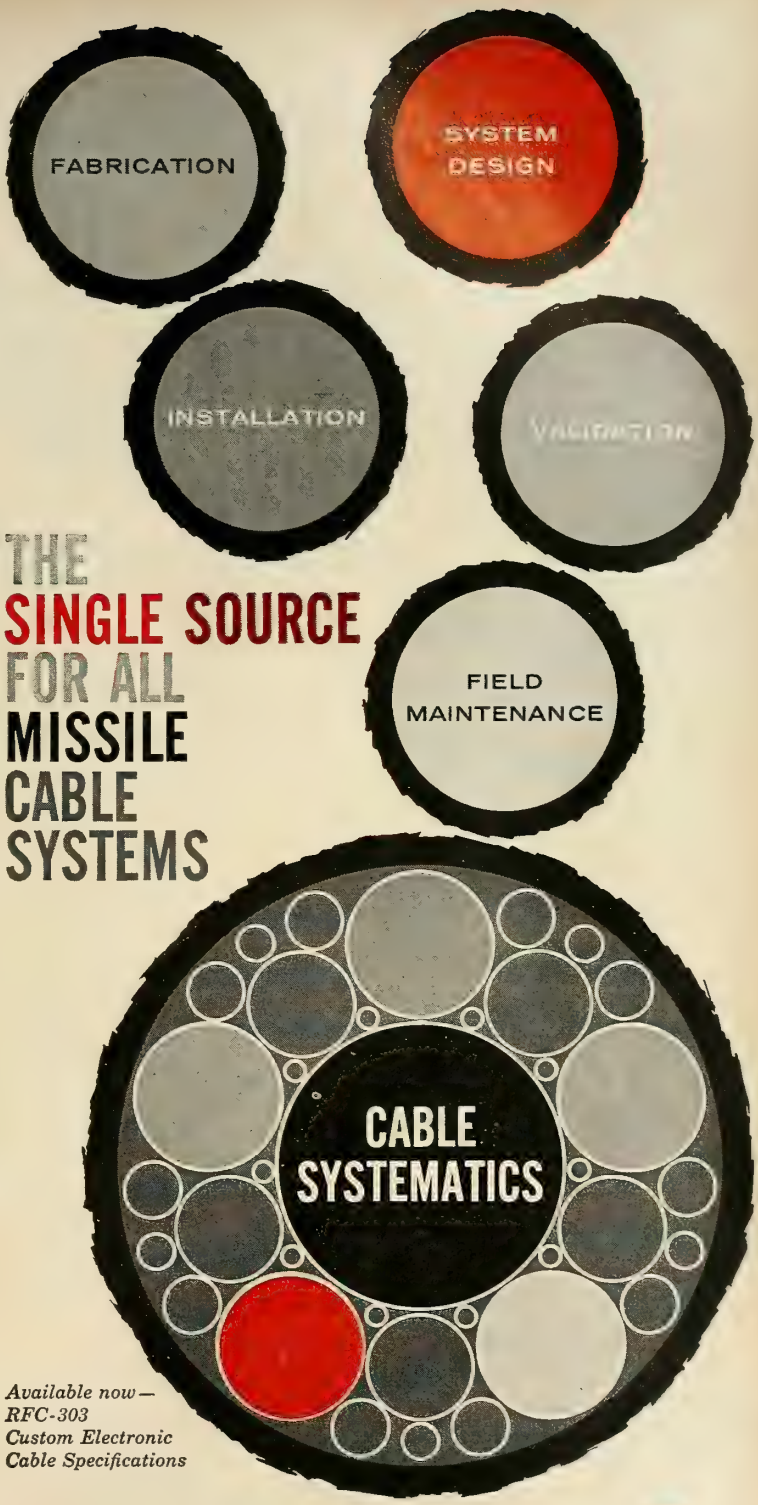
By District Engineer, U.S. Army Engineer District: J. W. Bateson Co. Inc. received $676,531 for Hawk engineering and contractor facilities. V & N Construction Co. received $153,981 for storage, base and rocket assembly; Walker Air Force Base.

By U.S. Army Engineer District, New York, Corps of Enginers: Middlesex Concrete Products & Excavating Co. received $143,018 for improvement program special AAA facilities. Nassau Construction Co. Inc., received $60,200 for improvement program special AAA facilities. Grant Park Construction Co. received $145,353 for improvement program special AAA facilities. Heroes Excavating and Contracting Corp. received $195,814 for special AAA facilities, conversion of *Nike Ajax* to *Hercules*.

By U.S. Army Engineer District, Philadelphia: Keane Construction Co. Inc., was awarded $276,468 for construction of conversion to *Nike-Hercules* in the Philadelphia Defense Area. Peterson, Garbi & Joseph, Inc. received $147,000 for construction of high altitude training building, Little Rock AFB. Hardee Construction Co. Inc. received $119,655 for high altitude training building, Carswell AFB.

By U.S. Army Corps of Engineers, Office of the District Engineer: Toltz, King, Duvall, Anderson and Associated, Inc., was awarded $80,800 for contract plans for four *Nike* installations. Consolidated Diesel Electric Corp. received $5 million for ground support electrical generators.

By U.S. Army Engineer District, Mobile, Corps of Engineers: Blount Bros. Construc-



AERONAUTICAL AND INSTRUMENT DIVISION

Robertshaw-Fulton CONTROLS COMPANY

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op′ por·tu′ ni·ty



KEY OPENINGS IN 4 ADVANCED ENGINEERING AREAS AT VOUGHT

ADVANCED WEAPONS

This Vought division is planning, analyzing and proposing new concepts in missile and fighter weapon systems. Here, tactical requirements are established for new weapons, feasibility studies conducted, and proposals prepared.

Select openings exist in both the Advanced Missile Technical Group and the Advanced Aircraft Technical Group. These are responsible positions for engineering specialists and for design engineers up through lead level. Following are requirements for 5 openings which are typical of others in these groups:

Electro-mechanical Systems Analyst. A.E., E.E., or M.E. (advanced degree preferred) with 8 to 10 years experience in analytical design of guidance controls, flight mechanics, dynamics, or comparative applications of applied math. To study advanced weapon systems for guidance, controls, autopilots.

Radar System Engineer or Specialist. A.E., or E.E. (M.S. preferred) with at least 7 years experience in systems and/or design for radar and fire control. To make high-level studies of advanced guidance and control systems.

Advanced Weapons Staff Engineer. Ph. D. preferred, with at least 10 years background in guidance or navigation and control systems. To develop completely new concepts in guidance, navigation, or control systems.

Electro-mechanical Systems Engineer or Specialist. A.E., E.E., or M.E. (advanced degree preferred) with at least 7 years experience in autopilot, flight control, stability systems and inertial guidance systems and design work. To make high-level technical studies of various control and stabilization systems for advanced weapons.

Advanced Weapons Engineer. A.E., E.E., or M.E. (M.S. desirable) able to develop methods for dynamic stability and stabilization studies. To join in, or direct, studies in stabilization, dynamic stability, missile and airframe configurations, and to make flight path and trajectory analyses. All in supersonic and hypersonic range.

AERODYNAMICS

Some of Vought's most vital and interesting problems are in general aerodynamics and automatic flight controls for supersonic and hypersonic weapons. This work involves trajectory and configuration analyses, autopilot studies, control system synthesis and other responsible investigations. Helpful in a number of areas are Vought's low- and high-speed wind tunnels with a speed range from Mach .05 to 5.0.

A limited number of additional specialists may find assignments to match their skills in Vought's aerodynamics activities. These men may have general aerodynamics experience, or a good background in automatic flight control systems. Illustrative of openings available are these 2 posts:

Autopilot Engineer. A.E., E.E., or M.E. (M.S. desirable) plus at least 3 years experience in stabilization, or autopilot and servomechanism analysis and design. To assist in, or direct, autopilot studies and designs for supersonic airplanes and missiles.

Aerodynamics Engineer. Aerodynamics Engineer with A.E., or equivalent, and at least 3 years experience. To work on supersonic aircraft and missiles in aerodynamic analyses of performance, air loads, stability and control, or fluid mechanics.

STRUCTURES

Structures work at Vought is an interesting combination of research, analysis, design and test—a mixture of practical and theoretical problems. Model tests in wind tunnel and on rocket sleds, together with high-speed digital computation, are used extensively for stress, flutter analysis, and dynamic response calculations.

At lead and staff levels in this activity, a few positions of responsibility are open. Especially attractive to men with solid backgrounds in applied mechanics or mathematics, or to men with wide knowledge of structural aircraft elements, are these 3 immediate openings:

Engineering Specialist. Requires Ph. D. To conduct R & D in structural and dynamic loads determinations, or to apply advanced mechanics theories to the solution of structural design problems where high temperatures are a prime factor.

Solid State Physicist. Ph. D. preferred, with at least 5 years experience. To assist in studies of: corrosion control; nuclear radiation damage; parts or systems failures for which no causes are apparent; basic phenomena of solids leading to new concepts.

Lead Structures Test Engineer. Engineer (M.S. preferred) with 5 years experience in structures or related field covering power controls, hydraulics or hydraulic systems, and control systems. To direct groups of engineers in work on structural aircraft elements, components and complete aircraft, including test work and report writing.

ELECTRONICS

Electronics activities are broad and fast-growing at Chance Vought. Projects involve advanced guidance and control and fire control systems for missiles and high-performance manned aircraft. They begin with investigations and theory and progress through systemization and packaging to detailed hardware design. Key responsibilities await additional men who are qualified in these areas. Advanced degrees are preferred. Following are 4 openings in this area:

Stability and Control Engineer. E.E., M.E., or A.E. with emphasis on flight stability and control problems or dynamics. (Special consideration given graduate study or extensive experience in transients or closed loop stability analysis.) To assist in design of autopilot and control systems for high-performance missiles and aircraft.

Antenna Design Engineer. E.E., or Physics Degree with demonstrated aptitude for antenna design. To join active projects involving design of flush-mounted, recessed and external antennas at all frequencies for very high-performance aircraft and missiles.

Fire Control and Microwave Systems Engineer. Requires E.E., or Physics Degree; at least 2 years experience in radar, data link, or fire control systems; and strong ability in this work.

Test Equipment Engineer. Requires E.E., or Physics Degree and at least 2 years experience in this or related field. (Desirable: broad background in electronics design with emphasis on digital computers or microwave systems.) To join in the design of complete checkout systems for missiles and associated subsystems.

To arrange for a personal interview, or for a prompt report on these or other current openings, return coupon to:

C. A. Besio
Supervisor, Engineering Personnel
CHANCE VOUGHT AIRCRAFT, Dept. P-4
Dallas, Texas

I am a_____ Engineer,

interested in the opening for_____.

Name_____

Address_____

City_____ State_____

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INCORPORATED · DALLAS, TEXAS

Vought Vocabulary

re·lent′less: *a missile that pierces hostile sky to pinpoint its nuclear strike*

When a target's latitude and longitude are marked on this missile's brain, an appointment has been made.

To keep its rendezvous, the Chance Vought *Regulus II* performs miracles of navigation: it will launch stealthily from submarines – nuclear and conventional – from surface craft and mobile shore launchers. It will compensate automatically for wind and weather and for the earth's rotation. It will detour enemy strongpoints, outfox known counterweapons. Closing in on its quarry, it can plummet from over 60,000 feet to smokestack height to escape radar detection.

In minutes, *Regulus II* can pierce over 1,000 miles of hostile sky to score a nuclear bull's-eye.

The first of the Navy's nuclear-driven subs, designed to roam the seas as unseen *Regulus II* bases, is now in construction. The missile itself has made over 25 successful flights. Under Navy leash in key locations, it will be a relentless watchdog for peace.

Scientists and engineers: pioneer with Vought in new missile, manned aircraft, and electronics programs. For details on select openings write to: C. A. Besio, Supervisor, Engineering Personnel, Dept. P-3.

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. . . contracts

tion Co. received $1,506,154 for construction of interim troop housing at Redstone Arsenal. E. F. Gunn Construction Co. received $129,982 for construction of rocket storage. Westinghouse Electric Corp. received $151,265 for oil circuit breakers and transformers, Eglin AFB. Moloney Electric Co., received $43,971 for voltage regulators for Eglin AFB.

Lacrosse: The Army has let another research and development contract in connection with the 20-mile-range *Lacrosse*. The contract, amounting to $1,746,930, was awarded to Cornell Aeronautical Laboratory, Buffalo, N.Y. Contracts have also reportedly been awarded by the Air Force to Food Machinery and Chemical Corp. for launchers for the latest version of *Bomarc*. Developmental launchers were built by American Machine & Foundry Corp. It is also understood that Goodyear Aircraft at Phoenix, Arizona, has been awarded a contract to make the ground handling equipment for *Atlas*.

Electronic equipment and maintenance spare parts kits: $10,831,030 by **Army** to Burroughs Corp.

Plato: $4.5 million for research and development to Sylvania Electric Products, Inc., by **Army**.

Solid rocket development: $1.5 million to Aerojet-General Corp., by **Air Force**.

Snark Launchers: $1 million to Nuclear Products—Erco div., ACF Industries, Inc., **by Northrop.**

By U.S. Army Signal Supply Agency: National Co., Inc. received $42,500 for frequency standard atomic atomichron. Board of Regents of University and State Colleges of Arizona, received $30,923 for combined study and investigation of an experimental transistorized distributed amplifier. Arthur D. Little, Inc. received $25,924 for standard "Arthur D. Little" collins helium cryostat. Syracuse University Research Corp. received $48,548 for research on radar sensors. Admiral Corp. received $70,870 for antenna models.
U.S. Army Engineer District, Pittsburgh, Corps of Engineers, received $204,781 for construction of F.U.I.F. room addition and generator building modifications at control area of *Nike* sites.

By U.S. Army Engineer District, Jacksonville, Corps of Engineers: Anchor Post Products, Inc. of Florida received $45,769 for construction of security fence for complexes 11, 12, 13 and 14, AFMTC, Patrick AFB. Paul Smith Construction Co. received $1,364,349 for construction of G/M lab engineering, SM-62 and base communications buildings. Maurice H. Connell and Associates, Inc. received $60,000 for design of complex 29 facilities and facilities in missile assembly building.

By Boston Ordnance District, Army Base, Boston, Mass.: Anderson-Nichols and Co. received $42,605 for design & development of data-recorder instrument.

By Rome Air Force Depot, U.S. Air Force, Griffiss Air Force Base: Collins Radio Co., was awarded $59,430 for single sideband equipment for SM-75.

By Dept. of the Navy, Office of Naval Research: Brown University received $25,428 for study of the three-dimensional state of stress in elastic plates. Hughes Aircraft Co. received $45,000 for development of a gridded controlled electron gun. Yale University received $47,199 for research on the effects of environment on the failure of metals; $30,000 for laboratory and theoretical studies of the fluctuation of acoustic waves in water.

By Air Force Cambridge Research Center, Air Research and Development Command: The University of Chicago received $30,000 for research relating to molecular structure-high resolution spectroscopy of atmospheric gases. Allied Research Associates, Inc. received $64,946 for research directed toward contrail elimination. The Johns Hopkins University received $30,000 for research concerning extreme ultraviolet gratting. Northeastern University received $40,000 to develop, modify, fabricate and test upper air vehicle components.

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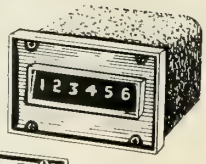
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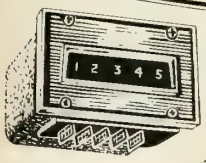
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missile business

by Seabrook Hull

One thing about the missile business—It takes some traveling. Anyhow, it does if you're going to make a go of it. The most obvious reason for travel is sales. But there are other reasons, just as important. For example, considering Pentagon classification, censorship, and need to know; compounded with the natural inclination of most companies to keep as much of the prime contract in the shop as possible; traveling is often the only way to learn about new business in time to get it. Also, to be a success in the missile business, you've got to sound like an expert. To sound like an expert, you must have a pretty good idea of what's going on. The only way this is done is by hitting the trail, talking to people, listening, pumping.

When traveling, you can also manage to keep up-to-date of who your competition is; what new processes have been developed; who's goofed; and where the next big contract is going to be placed. In a word, one important phase of selling missiles requires a continuing running market survey and analysis. You can't do this with your feet propped on your desk. Hit the road!

The missile, rocket and space flight business is twice as big as you think it is. Take a look at the expenditures. Missile procurement is pegged at $2.9 billion for the current fiscal year, and at $3.3 billion in 1959—not counting the supplemental appropriations. But this is only section "B" of the major budget item, Category III—Major Procurement and Production. This refers to the missile itself and its immediate support equipment. It doesn't include other support vehicles such as road missile transporters, fixed base liquid oxygen generators, storage tanks, and others. It doesn't refer to based electronics such as acquisition radar, site-to-site communications, and the like. Another major item not included in "Category III, B" is site construction—concrete, black top, barracks, bunkers, sewers, waterworks, telephone exchanges.

And perhaps most important of all, this category doesn't include research and development. This last item—major Category VI—will hit $1.8 billion plus this year and will top $2.1 billion in 1959. A large hunk of both figures is for missiles, rockets and space flight.

All these extras added together will probably raise the total missile market to twice the normally stated size. And, if you want to add to such items as Polaris-launching submarines, missile cruisers, Government financing of new production facilities—the market turns out to be even bigger.

Since the Pentagon is still at a loss on the matter, we did some looking ahead ourselves the other day at how the Federal Missile budget will look after fiscal 1959. Again, we're only talking about "Category III, B"—Missile Procurement and Production. We figure the missile, rocket and space flight market will develop something like this: 1960, $4.5 billion; 1961, $5.5-to-$6 billion; 1965, over $10 billion; 1970-75, over $15 billion. All figures are in terms of 1958 dollars and do not include inflationary rises.

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NORTHROP AIRCRAFT, INC., ANNOUNCES

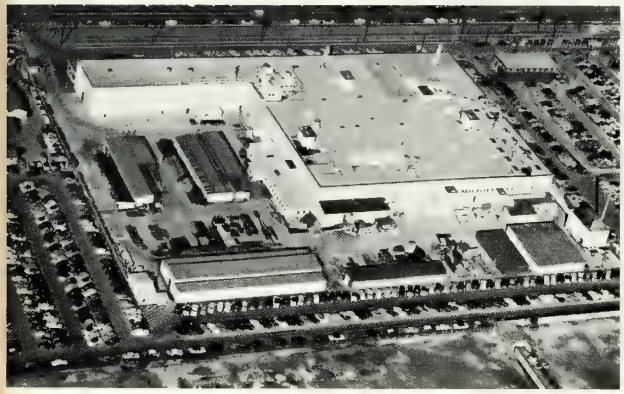
THE FORMATION OF NORTRONICS

A DIVISION OF NORTHROP AIRCRAFT, INC.

NORTRONICS

...GEARED TO THE SPACE AGE

Today, in the complex field of applied electronics, a new name, NORTRONICS, represents the combined talents of leading scientists, engineers, and technicians with production experience and capabilities. NORTRONICS, *new in name only,* is a combination of several Northrop facilities which had separately provided technical design, development, and production of electronic systems and systems support equipment. NORTRONICS provides a complete organization with the scientific knowledge, development techniques and production capabilities specifically required for the space age.



Nortronics' Electronic Systems and Equipment element, 222 North Prairie Avenue, Hawthorne, California.

In this NORTRONICS facility, comprising 300,000 square feet of plant area, Northrop established the nation's first unmanned weapon systems project. This program developed and produced the first successful systems for intercontinental inertial guidance. Today, airborne and ground based digital computers, automatic flight control systems, advanced infrared applications, and electronic and precision optical equipment are being developed and produced.



Nortronics' Systems Support element, 500 East Orangethorpe Avenue, Anaheim, California.

Here NORTRONICS is engaged in weapon systems support, including electronic test equipment; launching, loading and handling equipment; opto-mechanical fire control and sighting devices; and the most advanced techniques in physical countermeasures. The technology and facilities required to support such projects are housed in a 350,000 square foot plant area.



Compact automatic navigation system

AUTOMATIC FLIGHT CONTROL

A special research and development program of electronic miniaturization for advanced flight control application is now in progress at NORTRONICS. This is an outgrowth of nearly twenty years' experience in flight control systems for manned and pilotless aircraft. The fully powered systems on the Northrop P-61 Black Widow, the F-89 Scorpion series, and the SM-62 Snark missile were products of what is now NORTRONICS. These capabilities and production facilities are adaptable for the development of various types of flight control systems.

INFRARED INTELLIGENCE SYSTEMS

Homing systems for air-to-air missiles and infrared reconnaissance systems are natural outgrowths of development at NORTRONICS, following years of creative study. Considerable engineering development has resulted in experience in the fields of critical infrared systems and components, interference filters, reflecting optics, and sensor refrigeration.

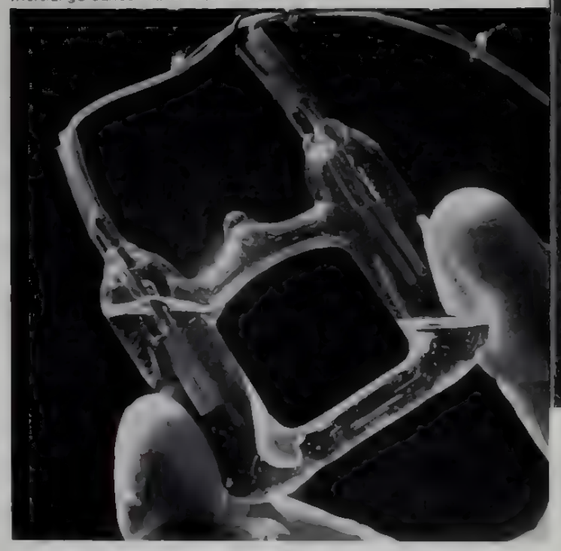
DIGITAL COMPUTERS

The engineering team that is now part of NORTRONICS developed advanced digital computing techniques employing a magnetic drum storage principle. The quadratic arc computer, identified as QUAC, followed and is now in production for the U.S.A.F. Later NORTRONICS engineers developed the first successful computer design employing the moving pick-off head principle. This computer series, known as GFC, is also in production. The requirement for lightweight, accurate airborne parabolic arc computer systems was met with APAC, a fully transistorized missile computer.

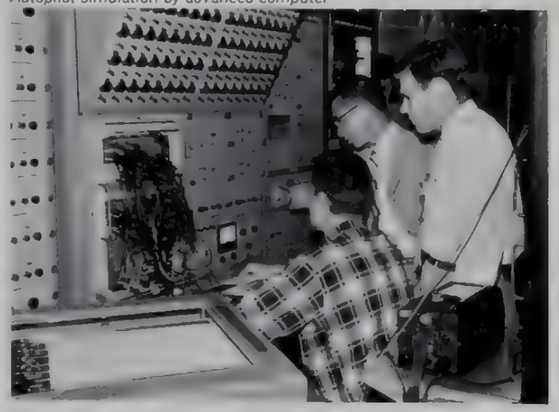
AUTOMATIC NAVIGATION

NORTRONICS scientists and technicians developed and produced the world's first successful intercontinental inertial guidance system. Aircraft and missile guidance systems of extreme accuracy and reliability, utilizing automatic star-tracking, are now in production. This vast experience has led to unique capabilities for the development of interplanetary navigation systems. NORTRONICS operates complete testing and manufacturing facilities for numerous types of automatic navigation systems.

Inertial guidance manometer accelerometer



Autopilot simulation by advanced computer



Rapid digital computer memory drum



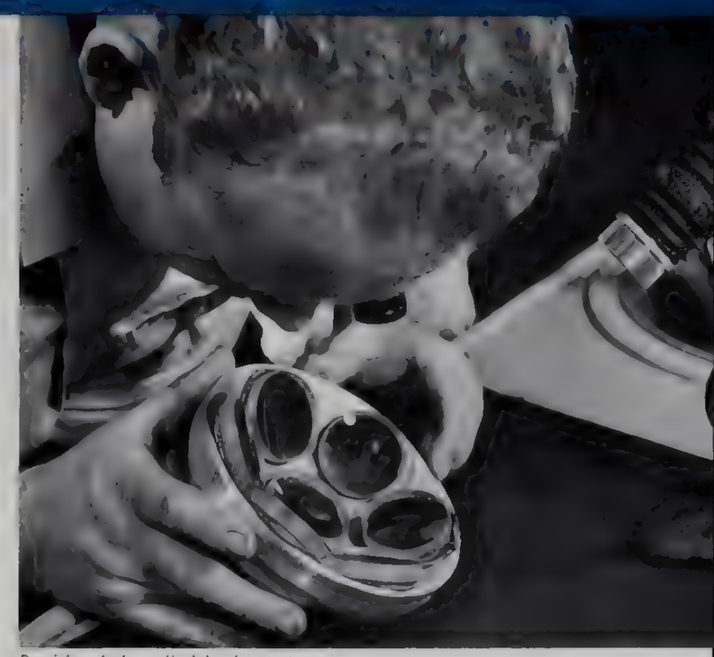




Electronic support test equipment

ELECTRONIC TEST EQUIPMENT

Experience in the field of automatic test systems for complex weapons includes the design, development, and production of a complete line of operational support equipment for the SM-62 Snark missile guidance system. Latest in a series of successful test equipment is DATICO, a digital automatic tape intelligence checkout system. DATICO provides a major reduction in the time and costs involved for the testing of all types of weapons. The versatility of this equipment is demonstrated by its current application to five weapon systems.

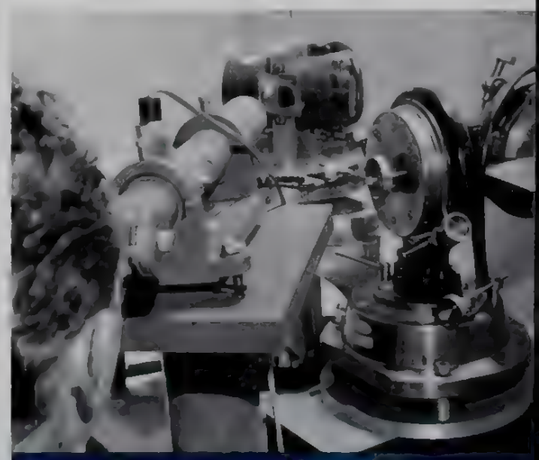


Precision electro-optical development

ELECTRO-OPTICS

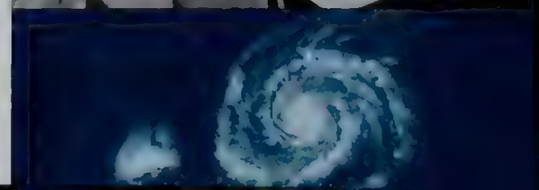
In one of the nation's most complete optical laboratories, NORTRONICS combines advanced navigation systems with new developments in optical science. NORTRONICS' modern optical laboratory is staffed with specialists of outstanding and unique skill and experience. Here a wide range of precision optical elements is produced, ranging from simple prisms to specially designed test equipment and precision lenses. At present, these NORTRONICS scientists and technicians are specifically qualified to conduct advanced research for interplanetary navigation.

High precision optical test equipment



ENVIRONMENTAL TEST FACILITIES

The wide range of environmental conditions encountered by all types of electronic systems can be duplicated by NORTRONICS' extensive test facilities. Extremes of temperature, altitude, humidity, pressure, and sound frequency are simulated, as well as combinations of random and sinusoidal vibrations that occur during flight. Additional NORTRONICS testing equipment is constantly being designed and developed to meet changing requirements.



A DIVISION OF NORTHROP AIRCRAFT, INC.

FIRE CONTROL AND SIGHTING DEVICES

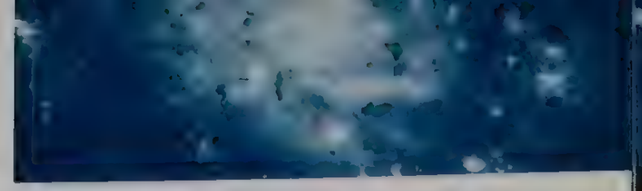
Experience in fire control devices and sighting sub-systems at NORTRONICS covers a wide range of production items. NORTRONICS has engineered, designed, tooled, and volume produced telescopes, periscopes, range finders, plotting devices, and calibration and alignment fixtures for military and industrial applications.

LAUNCHING, LOADING AND HANDLING EQUIPMENT

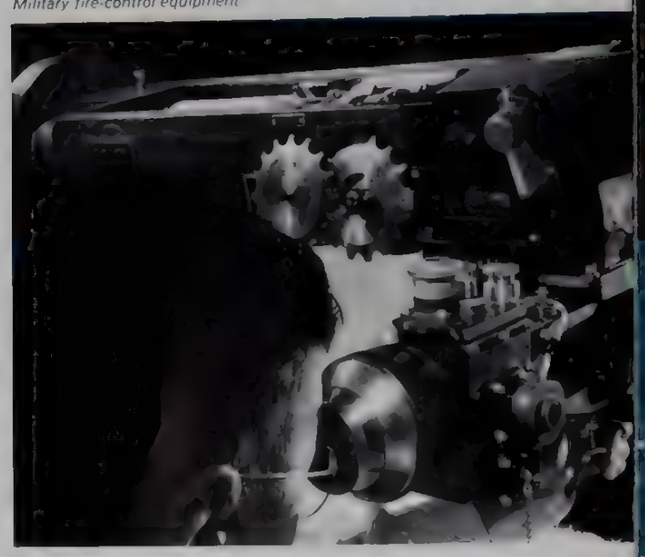
The capabilities of NORTRONICS cover the complete range of research, design, development, production and service of universal handling equipment for major weapon components. NORTRONICS is currently supplying Raytheon Manufacturing Company with pallets, loaders, launchers, and tactical containers for the Hawk missile, and has participated in other similar programs.

SUPPORT SYSTEMS DEVELOPMENT

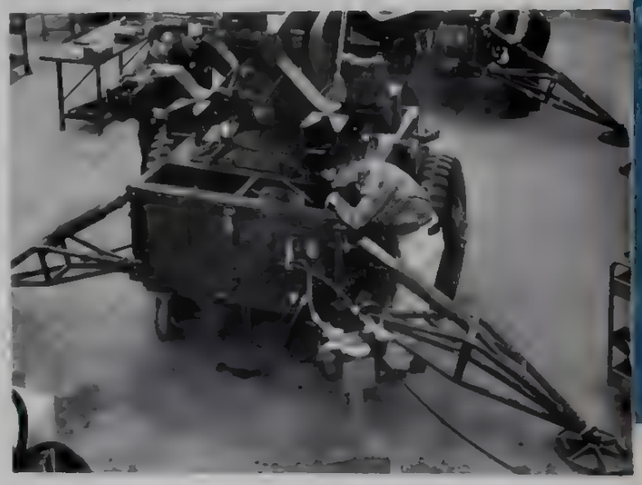
The design of support equipment must reflect understanding of the weapon, its operational and maintenance concepts, and the facilities and skills of its field operators. NORTRONICS' experience with military specifications, contracts and documentation, operational concepts, and the design and production of weapon systems support equipment provides maintainable precision support equipment having high reliability.



Military fire-control equipment



Ground handling systems assembly



Weapon systems support equipment



NORTRONICS

...GEARED TO THE SPACE AGE

Scientific knowledge of the highest degree, proven development techniques, and precision production abilities are demanded in today's space age. NORTRONICS, the new Division of Northrop Aircraft, Inc., is a unique combination of these required capabilities. Here are the scientists and engineers who have created such outstanding achievements as the world's first successful automatic intercontinental missile guidance system, now being produced by NORTRONICS' skilled technicians. Exploration and discovery in every field of aerial science and weapon systems is represented in the combined experience of NORTRONICS.

1—NORTRONICS is a *complete* organization. It offers systems analyses, applied research, design, development, engineering, laboratory and flight testing. It offers special environmental test facilities, assembly line manufacturing, production of training aids and technical publications, and field services.

2—The Engineering and Research staff of NORTRONICS includes over 450 scientists and professional engineers. More than 4,500 experienced people work in 650,000 square feet of plant area.

3—NORTRONICS designs, develops, and manufactures electronic, electromechanical and opto-mechanical systems, components and ground support equipment. In 1957, sales amounted to $60,000,000.

4—Advanced engineering research at NORTRONICS has resulted in the development and production of several types of highly refined analog and digital computers for both airborne and ground based applications.

5—Extensive experience makes NORTRONICS an important source of weapon systems support equipment. Now in production, for example, is electronic and mechanical ground support equipment for leading United States missiles.

6—NORTRONICS' completely equipped optical laboratory is manned by technicians with unique skills and experience in developing high precision optical elements and systems.

7—NORTRONICS' scientists and engineers pioneered in celestial and inertial guidance and navigation systems. This experience is particularly applicable to the development of infrared guidance and interplanetary navigation systems.

The research facilities as well as the development and manufacturing capabilities of NORTRONICS are now supporting U.S. science, industry and military services. For further information write to: NORTRONICS, A Division of Northrop Aircraft, Inc., 222 North Prairie Avenue, Hawthorne, California.



west coast industry

by Fred S. Hunter

Half-ton U.S. Satellite?—There have been reports in Pasadena, where Caltech's Jet Propulsion Laboratory is located, that the Army is undertaking a full-scale satellite program aimed at orbiting a half-ton satellite before the International Geophysical Year ends. And Marvin Miles, the Los Angeles Times aviation editor, has been trying to find out if JPL is engaged in a study for a solid propellent ICBM for the Army. But he got no clues from Dr. William Pickering. In answer to Miles' question, the JPL director merely pointed out that the facility does not engage in projects as such, but rather performs the research paving the way for desired achievements. Miles' guess is that JPL actually is researching the possibilities of a solid ICBM for the Army.

More to come—J. L. Atwood, North American Aviation president, made an interesting observation at the annual stockholders' meeting. NAA's Rocketdyne division, he said, "has only begun to scratch the surface." It is going on to larger and more efficient engines. Another point: "There is a distinct and discreet division between liquid and solid propellant engines." Liquids are better for large engines; solids are advantageous for smaller engines, he explained.

What's in a name?—Marquardt Aircraft Co. calls its new research division ASTRO, which, of course, is a combining form from the Greek "astron" for star, but at Marquardt it means Air-Space Travel Research Organization. Roy Marquardt, incidentally, believes air-breathing engines accelerating to satellite velocities within the atmosphere will supply a very efficient way of setting up and servicing a manned space platform, which, he adds, will almost certainly be established within the next 10 years, "leading to colonization of our planets within our lifetime."

But if you think it would be romantic to go to the moon, listen to this observation from H. Guyford Stever, chairman of the Scientific Advisory Board committee on space technology: "Personnel assigned to scientific observations from moon stations will find it about as interesting as Thule Air Force Base."

Ramo-Wooldridge is sounding a new note in its personnel procurement advertising. Its help-wanted ads announce that its reconnaissance-data processing programs have created openings for engineers experienced in photogrammetry and in photo interpretation.

High cost of gyros—William R. Whittaker, president of Telecomputing Corp., told stockholders at the annual meeting that 10% of a *Nike's* cost is in its gyros. All of the *Nike's* gyros are produced by Telecomputing. "You can see what a nice business this is," he said. Telecomputing is now getting into production on gyros for the upgraded *Hercules.*

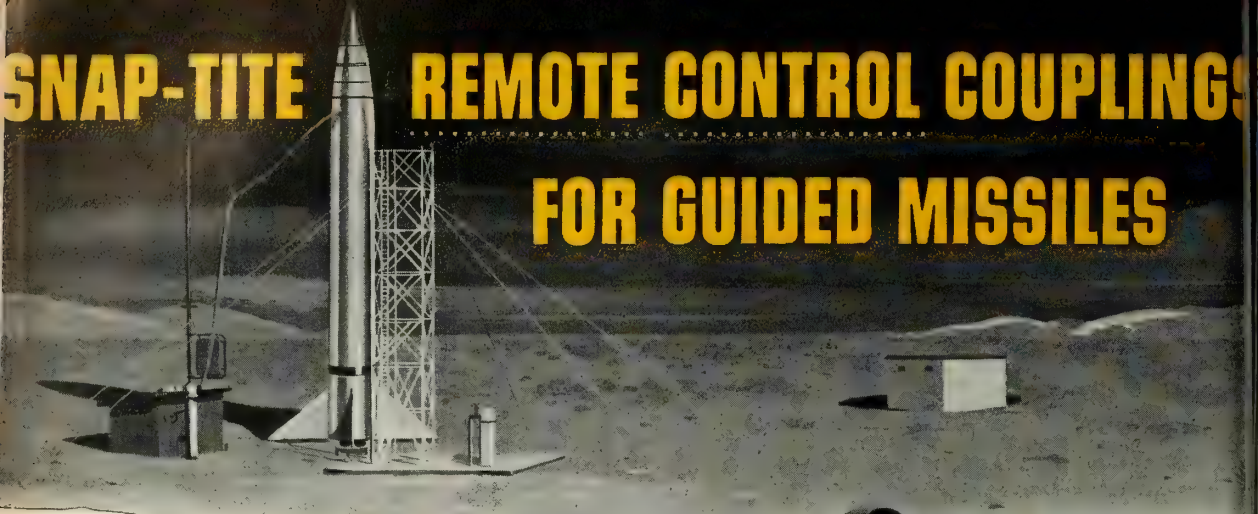


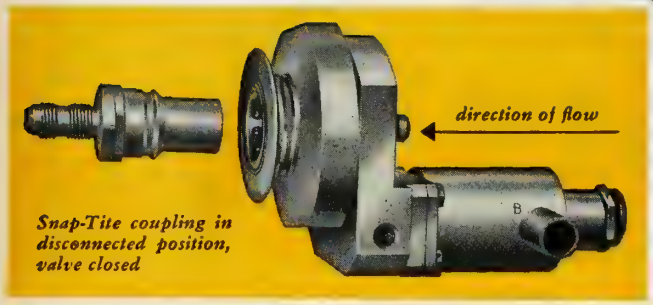
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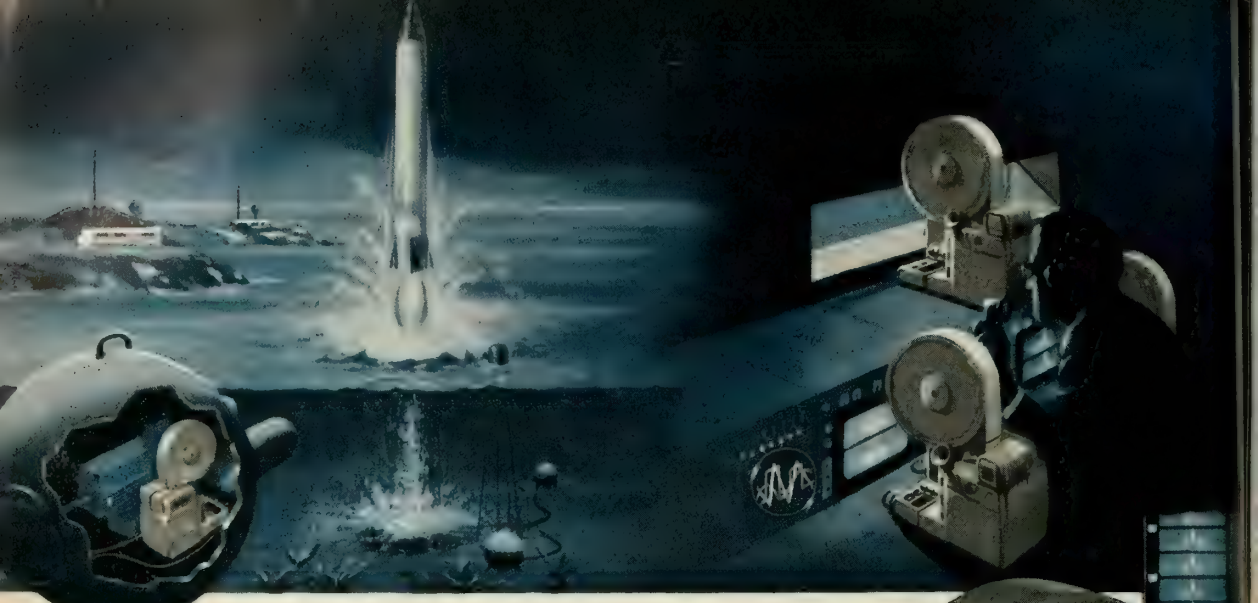
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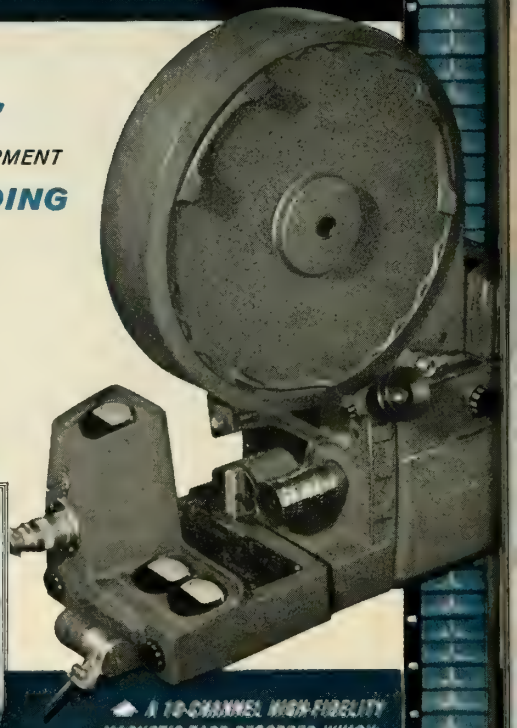
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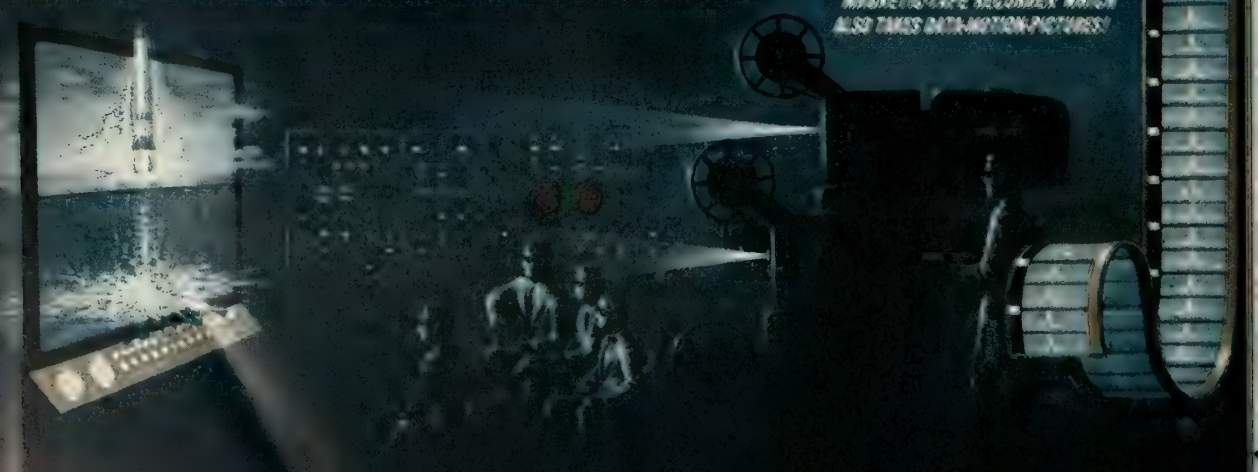
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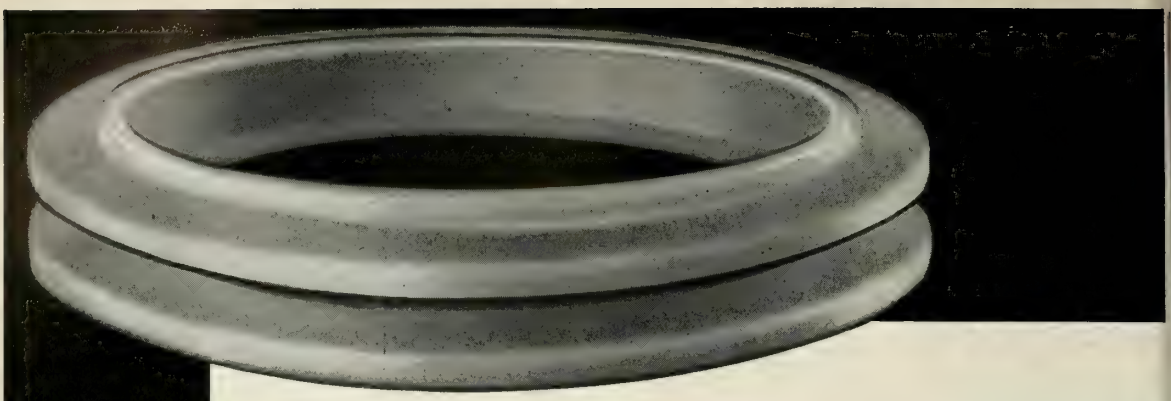
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washington trends

by William O. Miller

Reluctant brides might be one way of describing the three services, in regard to the President's reorganization proposals. Just how unpleasant the word "reorganization" sounds depends on whose shop you're in—with the Navy the most reluctant and the Army in the middle. Since the President pointed his finger at them, the information offices are watching and waiting. As far as can be determined, none of the information chiefs have been consulted. One thing seems sure—if the information merger goes through, security review activities will be greatly increased. Increased security or censorship will result, depending on how you look at it. The general feeling in all services is that turmoil will come just as the stormy common law marriage of the Services and DOD was beginning to work.

The second most important word—after reorganization—in Washington is "space," but there seems to be some difficulty in defining it. Every witness called before the new House Committee on Astronautics and Space Exploration were asked the same questions: "Where does space begin?" "How far should the Committee's jurisdiction extend?" Answers varied from witnesses Wernher Von Braun and Dr. Hagen. Von Braun suggested the Committee should stick to the solar system.

A new air-to-air missile system is being sought by the Navy as the answer to rising costs of high-speed aircraft. BuAer spokesmen say competition has been launched in an effort to enable missiles to carry out a larger part of interceptor duty. Fighters now being considered by the Navy carried small-lot price tags ranging up to almost $10-million each.

Liquid rocket auxiliaries for fighters and attack aircraft are becoming more important. The Navy still has not announced the winner of competition for a successor to the AR-1, but indications are that one of the first planes to use the new booster will be North American's A3J. Use of liquid rocket auxiliaries is slated for several other types.

A single specification for procurement of engineering drawings, to become effective within a year, is the latest goal of the Defense Department. At present, engineering drawings are prepared in accordance with about 28 different specifications. Two questions are being asked: "Who's going to pay for the standardization, and what is going to happen to the old drawings?" It takes about 30,000 drawings for the guidance system of a medium sized missile.

Improved packaging of liquid fuels is prompting more serious consideration of liquids as opposed to solids for missiles at both ends of the rocket spectrum. Development of an efficient cartridge-type loading for liquid fuels may replace solids in smaller birds. Reports say liquids may be considered for several of the air-to-air and air-to-ground missiles. The ability to control thrust of liquids keeps liquid fuel in the longer-range missile despite the fueling process. RMI is believed to be spearheading development in this field.

Postscript: There is no space for the Senate Space Committee on Capitol Hill—it is temporarily holding forth in the Home Owners Loan building.



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VOL. 3 NO. 6

MAY, 1958

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

Top Personnel Shortage Worries Industry

Government officials concerned as rising appropriations force greater work-load on small staffs of management-scientists

by William O. Miller

Of growing concern to both the military and industry is the increasingly limited number of men available who have the technical knowledge and managerial skill needed to develop and produce missiles.

Top levels in the Department of Defense are well aware that increasing the work-load of qualified personnel now on the payroll can result in a diminishing return, despite larger and larger appropriations by Congress.

As one remedy, the suggestion has been made that Advanced Research Projects Agency, or a similar agency, be empowered to screen new projects and developments in already active programs. The screening not only would be in regard to defense requirements, but also would consider available personnel and facilities.

Secretary of Defense McElroy, in a recent speech before the National Press Club, said that approximately 50% of the qualified technical personnel now available are already working on military or government-backed projects.

Those who know say this availability of scientists and engineers is about the limit of those who can be paid and persuaded to work on such projects—at least without a specified draft program.

Of slightly less concern but still important, is the pool of managerial talent which can be drawn upon to handle the special problems and considerations inherent in a rapidly expanding missile industry.

One Navy spokesman said, "The happy combination of managerial and technical ability that can undertake large rocket projects, particularly in the solid propellant field, is rarer than you might think."

Obviously, this was said in reference to possible siphoning off of personnel presently employed on programs such as *Polaris,* for use in development of other large solid propellant vehicles like *Minute Man, Pershing* and others.

Continuing, the Navy spokesman said:

"If you don't think this is true, just read the want-ad pages of our major metropolitan newspapers after a contract is let for research and development. You will see how the various companies are forced to bid for personnel already employed by similar orgainzations.

"In the national interest, future proposals for large rockets must be considered not only with an eye to overall defense planning, but also in view of the personnel and facilities available to develop such projects."

Knowledgeable personnel is further limited in military research and development agencies, and in the ranks of sub-contractors whose contributions can make or break a project. At the moment, there are some 48 missile projects in the works or in development.

• **How many and who**—A recent unofficial survey of key personnel in solid propellant and allied rocketry shows the total employed and where they are located:

Service program management and planning groups:

Navy—E. Mitchell (BuOrd)
R. Roberts (ONR)
Capt. L. Smith (Special Projects)
Cmdr. W. J. Corcoran (Special Projects)
Army—R. C. Swann (Redstone)
C. M. Hudson (Army Ordnance)
J. A. Chalmers (Army Ordnance)
N. Klein (Army Ordnance)
J. W. Dawson (OOR)
USAF—W. C. Fagan (WADC)
Maj. W. Henderson (ARDC)
Col. A. N. Hall (BMD)
Col. P. G. Atkinson (OSR)

Top-level non-service technical management in charge of large active programs:

A. Aerojet—R. D. Geckler
Thiokol—H. Ritchey
Grand Central—C. Bartley
Phillips Petroleum—E. Fiock
Olin-Mathieson (Reaction Motors)—J. J. O'Neil, G. Miller, Dr. Herndon
Atlantic Research—A. C. Scurlock
Standard of Indiana—Wayne Proell
Ramo-Wooldridge—B. Adelman
B. Allegany Ballistics Laboratory—C. D. McKinney, R. Winer
Jet Propulsion Laboratory—P. L. Nichols, Jr., F. E. Goddard
Rohm and Haas at Redstone—A. R. Deschere, H. M. Shuey, W. D. Niederhauser
Applied Physics Laboratory—W. Avery
C. NOTS—H. Hunter, W. McEvan
NPF—S. Skolnik
NOL—P. M. Fye
Redstone—R. C. Swann
Picatinny—A. Frye, C. S. Davis, A. Lopresti

Scientists with broad background in solid propellants who contribute on a "consultant" basis:

W. Avery	(APL)
L. G. Bonner	(Hercules)
F. T. McClure	(APL)
B. Crawford	(Minnesota)
F. H. Westheimer	(Harvard)
Frank Long	(Cornell)
Wendall Jackson	(DuPont)
A. M. Ball	(Hercules)
G. Kistiakowsky	(Harvard)
H. W. Emmons	(Harvard)
R. H. Olds	(NOTS)
S. I. Cheng	(Princeton)
A. J. Stosick	(Union Carbide)
D. Altman	(Aeronutronics)
B. H. Sage	(Calif. Inst. Tech.)
John Kincaid	(Rohm & Haas)
A. L. Antonio	(GT & R)

. . . personnel shortage worries industry

E. T. McBee (Purdue)
Clayton Huggett (Rohm & Haas)
M. J. Zucrow (Purdue)
B. Lewis (Combustion & Explosives Research, Inc.)

Persons in immediate contact with specific areas of propellant work:

A. Propellant development
- Polyurethane composites—K. Klager (Aerojet), P. L. Nichols (JPL)
- Thiokol composites—R. S. Arrandale, J. W. Wiggins (Redstone), E. Sutton (Thiokol)
- Polybutadiene-acrylic acid, copolymer composite—E. Japps (Goodrich)
- Plastisol composites—L. Weil (Atlantic Research)
- Ammonium nitrate composites—W. A. Proell (Standard Oil of Indiana), E. Fiock (Phillips Petroleum)
- Nitropolymer composite—K. Klager (Aerojet)
- Double base (high energy)—A. Camp (NOTS), R. Preckl (ABL)
- Petrin-double base—W. D. Niederhauser (Rohm & Haas)
- Metal additives—K. Rumbel (Atlantic Research)
- Boron compounds—Eugene Miller (Olin-Mathieson), E. A. Weilmuenster, (Olin-Mathieson)
- N-F compounds—W. D. Niederhauser (Rohm & Haas), W. H. Pearlson (Minnesota Mining & Mfg.)
- New Ingredients—Charles J. Marsel (NYU), W. S. McEwan (NOTS), P. O. Tawney (U.S. Rubber), E. A. Weilmuenster (Olin-Mathieson), W. D. Niederhauser (Rohm & Haas)

B. Theory and design
- Combustion instability—(see list of participants in recent DOD meeting on combustion instability)
- Deflagration-to-detonation transition—C. L. Zernow (Aerojet), H. M. Shuey (Rohm & Haas), J. E. Ablard (NOL), D. Altman (Aeronutronics), M. A. Cook (Univ. of Utah)
- Theory and thermochemical—K. E. Rumbel (Atlantic Research), A. O. Dekker (Aerojet), P. L. Nichols (JPL), R. Steinberger (ABL), H. M. Shuey (Rohm & Haas), D. Altman (Aeronutronics), W. S. McEwan (NOTS), A. S. Gordon (NOTS), F. A. H. Rice (NPF), F. T. McClure (APL), J. A. Rottenberg (Univ. of Minnesota), R. H. Olds (NOTS)
- Ignition—J. H. Wiegand (Aerojet), G. J. Bryant (NOL), J. C. Brier (Univ. of Michigan), J. E. Pelham (Thiokol)
- Ballistic design—J. I. Schaffer (JPL), R. Winer (ABL), J. W. Wiggins (Thiokol), K. E. Rumbel (Atlantic Research), E. W. Price (NOTS), H. M. Shuey (Rohm & Haas)

C. Physical Properties—F. J. Lavacot (NOTS), P. E. Newman (ABL), E. H. Lee (Brown Univ.), P. J. Blatz (Aerojet), plus members of JANAF Physical Properties Panel

D. Processing methods—F. J. Lavacot (NOTS), J. W. Wiggins (Thiokol), K. Klager (Aerojet), E. Fiock (Phillips Petroleum), E. R. Csanady (NPF), G. F. Cramolini (Minnesota Mining & Mfg.)

Even though the missile personnel shortage now applies only to the solid propellant field, a breakthrough in this field can result in broad across-the-board planning changes. Similar shortages exist in other fields. The personnel problem will continue to be acute as progress is made in other experimental projects.

Missile Experts Tell Congress How To Beat Reds In Space

Congress gingerly dipped a toe into space last month, liked the feel of it, and dived right in.

However, the new House Committee on Astronautics and Space Exploration, which began its first series of public hearings April 15, clearly was not on familiar ground. Even though Congressmen are not known for kid-gloving witnesses, the new Space Congressmen made it plain they were trying to learn.

The Caucus Room, which housed the first two weeks of hearings, became an informal classroom with an impressive array of missile and space experts as instructors.

Instructors included such men as Dr. Wernher von Braun, technical director, ABMA; Maj. Gen. John B. Medaris, chief of the Army Ordnance Missile Command; and Dr. Fred Whipple, director of the Smithsonian Astrophysical Observatory.

Sample questions asked by the Congressman were, "Are the present thrust problems on rockets based on the same fundamental principles as Goddard's? Are the Russians using these same principles? How far up does space start?"

The committee has 11 bills before it—all almost identical—to establish a National Aeronautics and Space Agency.

• **Teeth needed**—The majority of witnesses favored a full-time, smaller board "with teeth," rather than the 17-member advisory board recommended in the Administration bill. Under this bill the board would be required to meet only four times a year and would function much like the NACA, which the new agency would absorb. Witnesses pointed out that their roles would be different; that whereas NACA conducted experiments, it was the DOD which negotiated the contracts based on those experiments.

Space Committee Members

Members of the House Select Committee on Astronautics and Space Exploration:

Chairman, John W. McCormack (D-Mass.); Overton Brooks (D-La.); Brooks Hays (D-Ark.); Leo W. O'Brien (D-N.Y.); Lee Metcalf (D-Mont.); William H. Natcher (D-Ky.); B. F. Sisk (D-Calif.); Joseph W. Martin, Jr. (R-Mass.); Leslie C. Arends (R-Ill.); Gordon L. McDonough (R-Calif.); James G. Fulton (R-Pa.); Kenneth B. Keating (R-N.Y.); Gerald R. Ford, Jr. (R-Mich.).

Members of the Senate Special Committee on Space and Astronautics

Chairman, Lyndon B. Johnson (D-Texas); Richard B. Russell (D-Ga.); Theodore Francis Green (D-R.I.); John L. McClellan (D-Ark.); Warren G. Magnuson (D-Wash.); Clinton P. Anderson (D-N.M.); Stuart Symington (D-Mo.); Styles Bridges (R-N.H.); Alexander Wiley (R-Wisc.); Bourke B. Hickenlooper (R-Iowa); Leverett Saltonstall (R-Mass.); John W. Bricker (R-Ohio); Karl E. Mundt (R-S.D.).

NASA will have cognizance not only over research and development but will have power to let contracts.

Consensus of witnesses: Congress would do better to look to the Atomic Energy Commission, which has a powerful full-time five-member board, as a model for the new agency.

The main point put across by witnesses was the urgency of overtaking Russia's lead. They said the United States should:

(1) Make a thorough study of European educational systems as a basis for overhauling our own.

(2) Cut the lag in putting new developments into production. Adm. H. G. Rickover, Assistant Chief, Nuclear Propulsion, Bureau of Ships, said Russia's lead time, from the inception of an idea until it rolls off the assembly line, is "one-half of ours."

(3) Keep R&D teams intact after projects are completed.

(4) Once the ball is rolling on a space program, keep up a sustained effort, based on planning as much as 15 years ahead.

(5) Get foreign technical documents translated faster and into the hands of the scientists. Adm. Hayward pointed out that the Russians are spending $1 billion annually translating "every technical document that comes out of the Free World."

(6) Keep the new agency from over-entanglement in unnecessary security classification.

(7) Pay government scientists more.

(8) Keep the new space agency independent of the military. Adm. Rickover stressed that civilian-run projects were always "more efficient" than those run by the military. He added that he was convinced the *Nautilus* atomic submarine program could have developed more quickly under civilian control.

(9) Spend more money on basic research.

• **Schriever appears**—On the day following the Air Force launching of a *Thor-Vanguard* combination from Cape Canaveral, Maj. Gen. Schriever, head of the Air Force's Ballistic Missile Division, ARDC, appeared before the committee (see also p. 70).

The Air Force missile chief told the committee that projects should remain where they are, even after the establishment of a space agency. He recommended that NACA should be the block upon which the proposed new agency will be based. He also said he favored from three to five military men on the proposed 17-man committee.

The current hearings are expected to continue into the middle of May.

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Congressman Moss; Douglas; Kimball; Cook; Crosby; Kantrowitz to chair panel discussions in Washington June 4–6. First Goddard Memorial Dinner will conclude conference.

FUTURE OF THE NATION'S missile-space industry will be analyzed in Washington next month at the First National Missile Industry Conference, sponsored by the American Rocket Society's National Capital Section and the National Rocket Club.

Advance registrations for the three-day meeting, June 4-6 at the Mayflower Hotel, indicate more than 1,000 industry-government leaders will attend. Six panels are scheduled: Contracting and Negotiation, Government Roles and Responsibilities, Freedom of Information, Research and Development, Commercial Markets, and Business Forecasting.

Dr. Robert H. Goddard Memorial Dinner, honoring the nation's first rocket pioneer, will conclude the conference. Industry awards will be presented for special contributions to the advancement of missilry, rocketry and astronautics.

For the first time, the National Missiles and Rockets Award—similar to aviation's famed Wright and Collier Trophy Award—will be made to the person or individuals who in 1957 made the most outstanding contribution to the U.S. rocket, missile or astronautics program. The award will be presented by Wayne W. Parrish, president, AMERICAN AVIATION PUBLICATIONS, Inc., and publisher of m/r magazine.

• **Program**—Donald W. Douglas, Jr., president, Douglas Aircraft Co., Inc., will chair the opening session on Contracting and Negotiation. Moderator will be Warren R. Smith, assistant to the president, Fairchild Engine & Airplane Corp. A "Space Age" luncheon will be held honoring the U.S. satellite teams.

In the afternoon, Gen. Orval R. Cook, president, Aircraft Industries Association, will chair the Government Roles and Responsibilities panel. A reception will be held that evening in honor of the Army Ballistic Missile Agency and the Naval Research Laboratory space satellite teams.

On the second day, Rep. John E. Moss (D-Calif.), will preside over the Freedom of Information panel. Dr. Harold Wooster, director of Research Communication, Air Force Office of Scientific Research, ARDC, will serve as moderator.

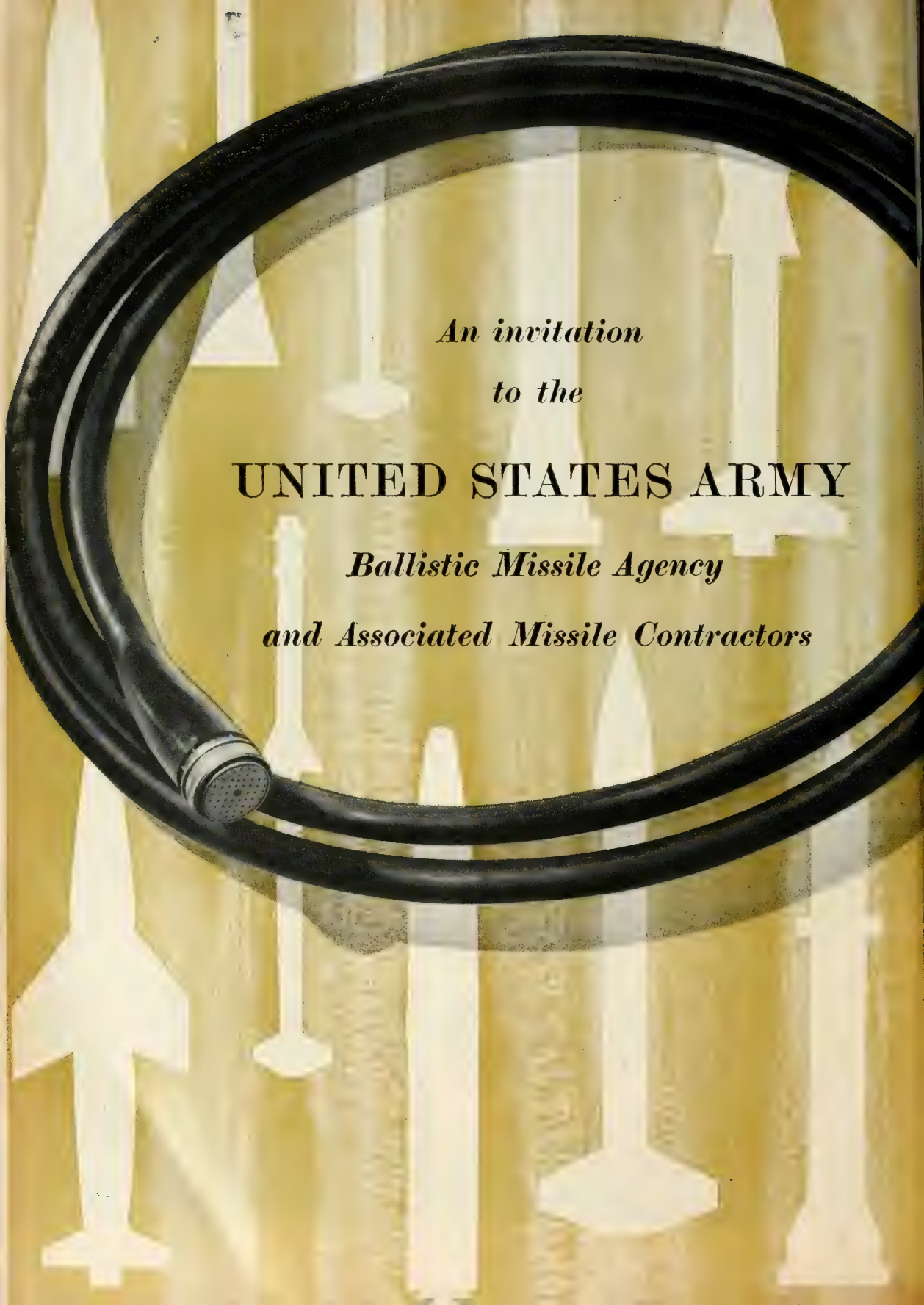
In the afternoon, Dr. Arthur R. Kantrowitz, director, AVCO Research Laboratories, will be chairman of the Research and Development panel. Moderator will be Thomas Wilcox, president, Thomas Wilcox Associates, Inc. A reception will be held that evening in honor of Mrs. Esther C. Goddard, widow of Dr. Goddard.

The last day's session on Commercial Markets and Business Forecasting will be chaired by Dan Kimball, president, Aerojet-General Corp., and J. W. Crosby, president, Thiokol Chemical Corp.

• **Ladies' Too**—Woman's Auxiliary of ARS' National Capital Section will have a special wives' program. Each discussion panel will average six members.

Among those scheduled to participate are: RAdm. John E. Clark, deputy director Advanced Projects Research Office; F. O. Detweiler, president, Chance Vought Aircraft, Inc.; Joachim H. Kauffmann, president, Diversey Engineering Co.; H. L. Thackwell, Jr., vice-president, Grand Central Rocket Co.; Kenneth Ellington, Telecomputing Corp.; Dr. Richard Kershner, Applied Physics Laboratory, Johns Hopkins University; Col. John R. V. Dickson, director, Development, ARDC.


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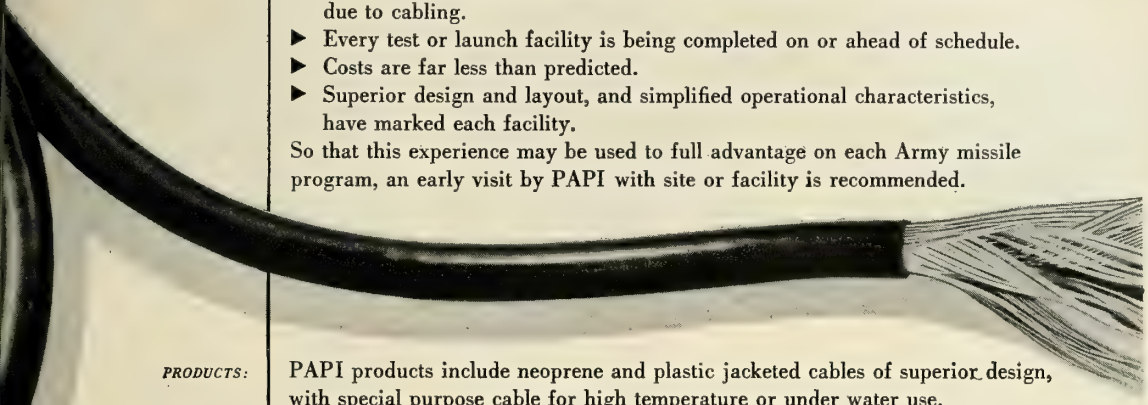
INVITATION: This is an invitation to utilize the missile systems engineering services of Pacific Automation Products, Inc., on current and upcoming Army missile programs.

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CONCLUSION: PAPI's engineering staff includes men with outstanding experience in every pertinent phase of the missile business. It is no accident, therefore, that we are the "take charge" sort of people who can take full responsibility for providing the services described in this message. We hope that you will accept this invitation and plan to utilize PAPI's great practical knowledge and experience in Army missile facility cabling and activation.

Arthur P. Jacob

ARTHUR P. JACOB, EXECUTIVE VICE PRESIDENT

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1943...LVT (A) 2
Amphibious Armored Personnel-Cargo Carrier



1944...LVT 4
Amphibious Personnel-Cargo Carrier



1944...LVT (A) 5
Amphibious Armored Assault Vehicle



1945...LVT 4 Lightweight
Amphibious Personnel-Cargo Carrier



1949...LVT (A) 5 Modified
Amphibious Armored Assault Vehicle



1951-1958...M59
Armored Personnel Carrier



1954...LVT P6
Amphibious Armored Personnel-Cargo Carrier

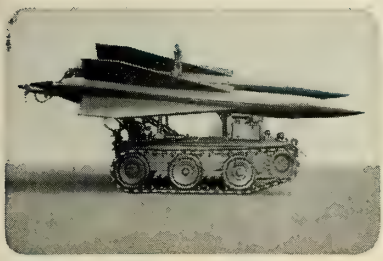


1955...LVTR-1
Modified Vehicle for recovery duty



1957...M-84
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HANDLE MISSILE LAUNCHER PROGRAMS



1957...HAWK
Mobile loader Vehicle



1958...THOR
Transporter-erector Launching Mount & Power Control Trailer

FMC's development of ground support equipment for major missile projects stems from over 17 years experience in producing mobile surface equipment for the Armed Forces

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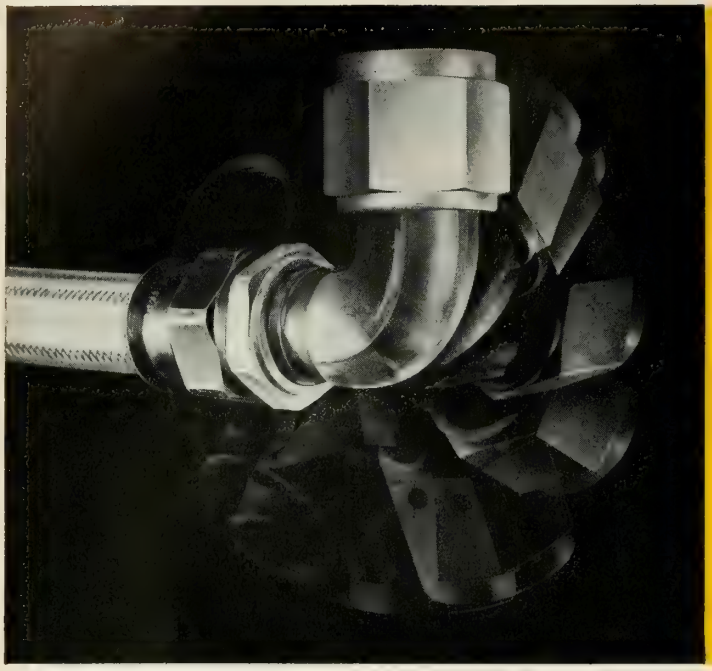
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Missile Equipment Section 1-A
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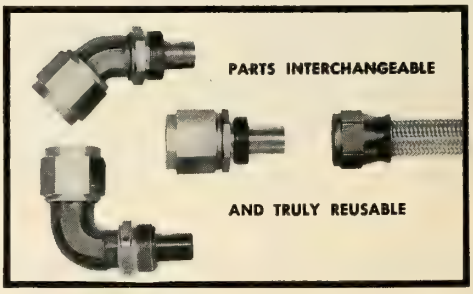
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Rear Adm. Raborn, USN, Navy Special Projects Office, with *Polaris* in background.

Polaris Details Emerge

On April 11, over 1,000 people converged on Washington's Sheraton Park Hotel for the Navy League's Seapower Symposium, celebrating the 58th anniversary of the launching of the first submarine, the SS Holland. The big news break in the missile business was the unveiling of the Navy's Fleet Ballistic Missile, *Polaris*.

A full-scale model of *Polaris* was displayed on the hotel's ballroom stage. With a height of 26 ft. 6 in. and a diameter of 54 in., *Polaris* is a two-stage solid propellant weapon with an ultimate design range of 1,500 nautical miles.

Polaris is designed to be carried in lots of 16 in specially-designed nuclear-powered submarines. It will be launched from under water by compressed air, with its rocket engine designed to ignite when the missile is airborne.

In an address made during the banquet, Rear Admiral W. F. Raborn, USN, Director, Special Projects Office of the Navy Bureau of Ordnance, said, "I firmly believe that we will have actual operational missiles in 1960."

With the marked success of the *Polaris* development program, it seems virtually certain that the limiting factor in this case is the time needed to produce and fit out the first submarines —rather than development of a successful missile. *Polaris* submarines are now already on the ways, with work proceeding under a wartime schedule of overtime.

Some details of the *Polaris* missile which were not officially released, but which became apparent in studying the model itself and movies shown of the test flight vehicles are listed below.

Polaris will be a two-stage bird. The first stage engine is 53 in. in diameter and 110 in. long. The second stage engine, which will provide both range and vernier control, is 53 in. in diameter and 47 in. long. This last stage reportedly will have thrust reversers for instanteous separation and cut-off.

Polaris engines will fire through multiple nozzles. Each nozzle will be equipped with a cylindrical jetavator for precision control. *Polaris* is shown as being completely finless. Admiral Raborn said that the new fuel already developed for *Polaris* constitutes a major technological gain.

Initially, *Polaris*' range may be limited by the strength of the thinwall motor casings. Reportedly, these have an initial ultimate yield strength of about 184,000 lb. psi, and with this strength the range will be somewhat under 1,000 miles. However, at 220,-000-to-240,000 psi, the full range of 1,500 miles will be realized.

Several companies, including Aerojet-General (*Polaris* engine contractor) and Thiokol Chemical (still a contender for a *Polaris* engine contract), are experimenting with stronger motor casings. Tolerances on these engines, incidentally, are on the order of plus-or-minus two-thousandths of an inch on the inside diameter with a wall thickness of less than 70/1000 in. The engine chamber pressure is about 1,000 lb. psi.

No details have been released as to how many *Polaris* missiles will finally be ordered, but it could be around 1,000. There's talk of building 40 *Polaris*-launching submarines which, multiplied by 16 missiles, comes out to 640 missiles. Add those needed for test and training and the initial production order totals 1,000.

In production, each missile will cost $500,000 each, making them the least expensive missiles of comparable range in the U.S. arsenal. This "savings," however, will be partially offset by the cost of the launching vehicle—the $80 million *Polaris* submarine and the submarine's Shipboard Inertial Navigation system.

Maj. Simons Volunteers for First Manned Rocket Ride

Maj. David G. Simons has volunteered his services for the first manned rocket flight into space, m/r has learned exclusively.

Simons, who set an altitude endurance record last August with a 32-hour-102,000-foot balloon flight, volunteered four months ago when the Army Ballistic Missile Agency first proposed sending a manned capsule spaceward. The Department of Defense has not yet given its approval.

The proposal was recently made public on the opening day of hearings of the new House Committee on Astronautics and Space Exploration. Dr. Wernher von Braun, Director of ABMA's Development Operations Division, told the Congressmen that the missile would take a man 150 miles into space and bring him back safely.

The pilot would be sealed in the missile's nose cone, which would separate shortly after burnout, and the capsule would then go through the apex of the trajectory.

During the five minutes the vehicle is in a gravity-free state, the pilot could "make all kinds of observations," von Braun said. The vehicle would land by means of a parachute and drag brakes. The entire flight would last ten minutes.

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Norris-Thermador—a leading manufacturer of compressed gas cylinders and pressure vessels for accumulators—also produces booster chambers and nozzles for improved performance rockets, missiles and aircraft.

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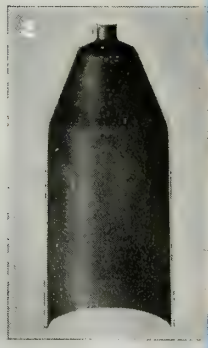
Norris-Thermador also fabricates multi-piece booster chambers and nozzles by cold-forming and welding. Dependable performance is assured by skilled workmanship and rigid acceptance standards, including X-ray, magnetic particle and metallurgical inspections, and hydrostatic pressure tests.

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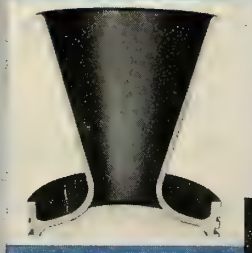


1. Fabricated Jato chamber

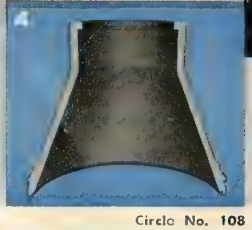
2. One-piece booster chamber cold-drawn from AISI 4130 steel blank. Wall thicknesses range from .130 to .425, with variations controlled to less than ± 5 per cent. No machining of the contours, internal or external, is required.



3. Fabricated rocket nozzle



4. One-piece booster chamber nozzle, formerly machined from a forging. Norris-Thermador reduced material and production costs more than 50 per cent by cold-forming the wall to the finished dimensions.



NORRIS-THERMADOR CORPORATION

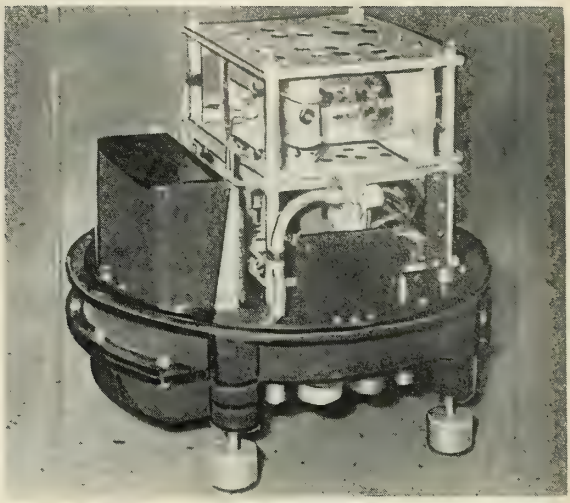
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Designers and Manufacturers of Rocket and Missile Components

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Soviet Reveals IGY Vehicles and Instrumentation

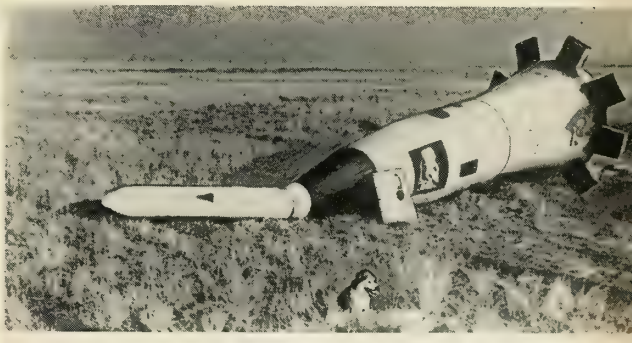


INSTRUMENTS installed in Soviet IGY rocket include ionization and magnetic manometers and above dispersion radiofrequency interferometer for the precise measurement of wave-lengths. The same type of electronic equipment was in Soviet *Sputnik* II.



RECOVERED instrument container of an IGY rocket is shown after being successfully recovered from an experimental flight. At the peak of the rocket trajectory, the container was separated and parachuted 132 miles to earth.



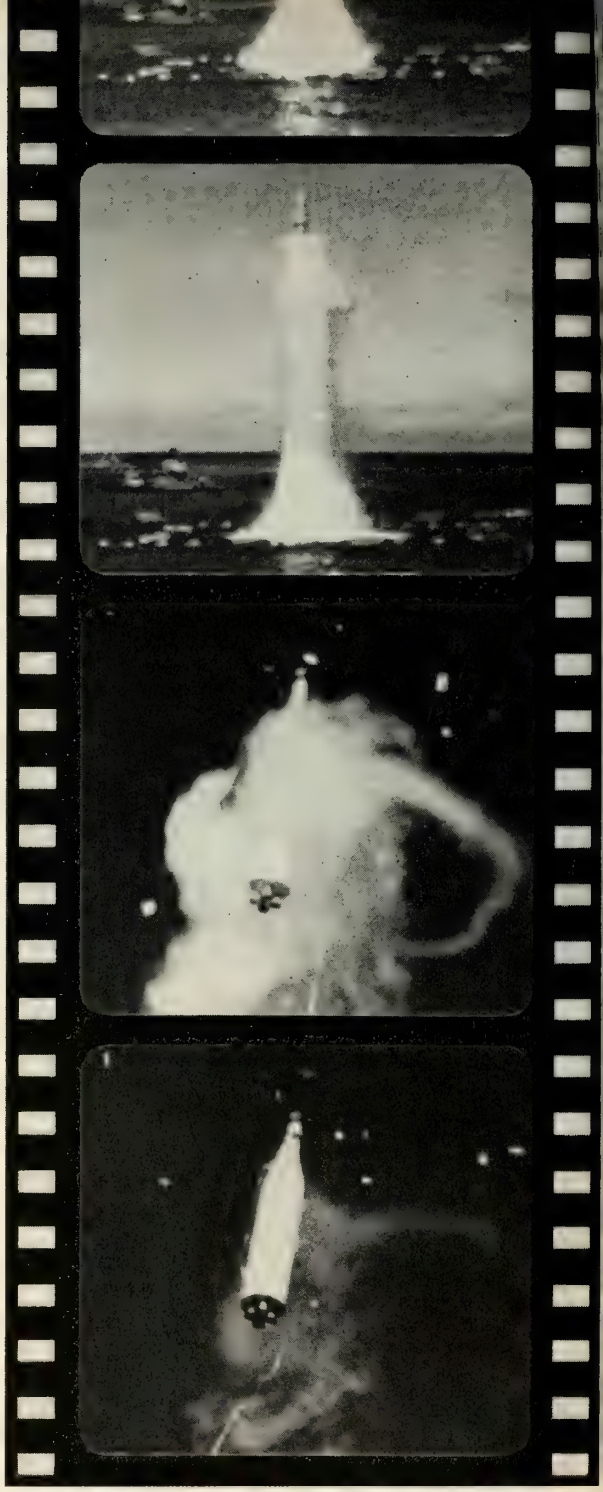


ANIMAL CHAMBER and instrumentation compartment of another Soviet rocket after being parachuted to earth from extreme altitudes. The dog in the foreground, apparently heavily retouched, has emerged from the recovered payload section.

LAUNCHING of a research rocket by the USSR during recent experiments. Projecting from the sides of the vehicle are the instrument compartments which separate and parachute to the ground.

Out of the Sea...





Symbolizing the Navy's future in underwater ballistic missile warfare, a *Polaris* FBM test vehicle erupts in a mighty geyser of water from its missile container anchored several feet below the surface of a Pacific test site. The *Polaris* is ejected vertically from its underwater container by compressed air in much the same manner as a torpedo. Note the four nozzles of the first stage, in the last photo.

Navy Unveils Bullpup At El Centro

The Navy has taken the wraps off the first air-to-ground guided missile especially designed to provide non-nuclear fire support to ground troops and tactical targets.

The missile was shown statically at the third annual Naval Air Weapons Meet in El Centro; although an on-again, off-again demonstration firing was cancelled. Apparently, the cancellation was due to bugs in the control system of one of the planes scheduled to participate, and not in the missile itself.

Another first which *Bullpup* can claim is that it is so designed as to practically eliminate the usual elaborate ground support system of maintenance and training. Due to its simplicity, the supersonic solid-propellant missile can be checked out at the factory; placed in storage up to six months; and have its three parts assembled and mounted on an aircraft in five minutes by a three-man crew.

Bullpup has been termed by one Naval spokesman as a "round of ammunition". The 10-foot, 600-pound missile can carry a variety of 250-pound bombs with a 40% greater punch than conventional 250-pound bombs delivered by conventional dive bombing.

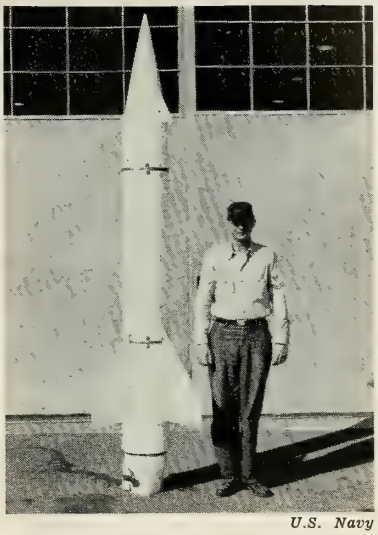
Bullpup is in line of sight weapons controlled by a direction button in the cockpit of the firing aircraft. The control gives up-down, right-left commands. By flying the aircraft, the pilot simultaneously flies the missile until zeroed-in on the target.

Guidance is by radio link, and it is assumed that tracking is by pyrotechnic flares or the like in the boattail. Movable snap-in canards on the nose control yaw and pitch during flight.

There is no homing system, and as a result, Captain James G. Sliney, assistant director of the Guided Missiles Division in the office of the Chief of Naval Operations, reported that *Bullpup* would probably be difficult for the enemy to jam.

The 300-pound solid grain rocket motor was first developed by Allegheny Ballistics, and is now being made by Aerojet General. *Bullpup* went into production with letting of an $8-million contract to the Martin Company in January.

Fleet delivery is scheduled for early fall. Naval spokesmen declined to give exact numbers, but they said deployment would be "good-sized". Due to its simplicity in mounting and firing, *Bullpup* will be ready for use immediately upon arrival in the Fleet.



U.S. Navy

STANDING ABOUT four feet higher than this 6′ 3¼″ tall sailor, *Bullpup* has a radio receiver in nose section, and carries any of several standard 250-pound bombs in center section. Aero-jet General builds the solid-grain motor.

Pilots who have been testing the missile have praised it highly for accuracy. A first test by one pilot resulted in a hit on a four-inch target at a firing range of two miles.

The Navy has been testing the bird on FJ4 Furies and A3D Skynights. First tests were on the prop-driven AD6. The Navy presently loads up to six *Bullpups* per plane.

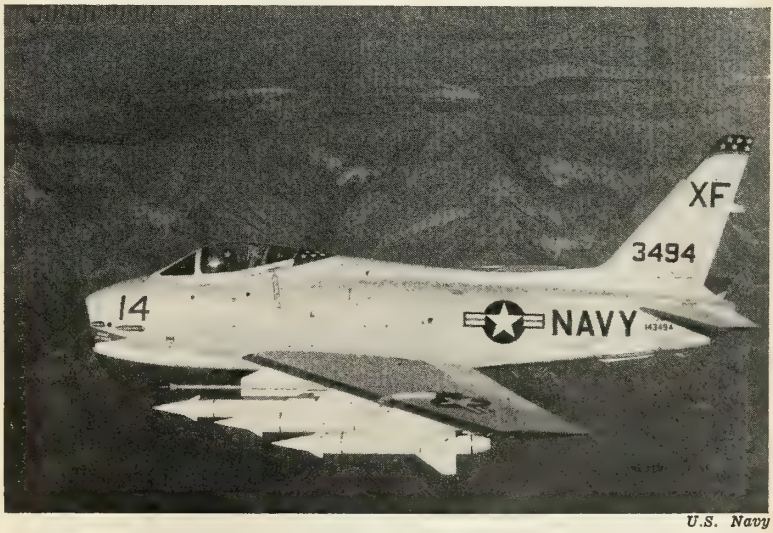
The Air Force has tested *Bullpup* on several aircraft including the F94 Starfire. Testing has been somewhat deterred due to the fact that *Bullpup* is stowed externally and does not have an all-weather guidance system.

Indications are that the guidance system will remain as it is for the present, although the missile and its warhead are due for further development in extended range, voice guidance and more accurate target acquisition.

Bullpup was first conceived during the Korean War, in which Navy and Marine fliers flew some 40% of the combat missions, particularly in close ground support and interdiction. Enemy ground fire, rugged terrain, and inclement weather resulted in heavy losses during low-level attacks.

This newest addition to the interdiction arsenal provides the Navy and Marines, both of whom will employ the missile, with the most potent non-nuclear weapon to date for use in both land-based and carrier-borne aircraft.

First mentioned a year ago at the Aviation Writers Association meeting in St. Louis, the *Bullpup* demonstration firing will probably be at Corpus Christi during the AWA meeting in Houston this month.



U.S. Navy

BULLPUP, **the Navy's solid propellant "Missile With a Bomb," is mounted on pylons of the FJ4 Fury. Supersonic at launch while aircraft is in dive toward target, *Bullpup* is guided visually by observations of pyrotechnic flares in boattail. The aircraft sends directional commands by radio, preventing jamming. Four snap-in canards on nose are actuated by up-down, right-left commands from cockpit. High reliability has enabled the Navy to eliminate costly testing and maintenance.**



All of the established Cherry High Clinch features are now in the "800" Monel rivets:
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. . . news and trends

Future Earth Satellites To Be Self-Serviced

Future satellites will have self-servicing devices remotely controlled from the ground, the House Space Committee was recently told.

Dr. Fred Whipple, Director of the Smithsonian Astrophysical Observatory, described what he called a "telepuppet" built into a satellite which could "duplicate what the operator's hands were doing on the ground" through telemetry.

Dr. Whipple pointed out to the House Astronautics and Space Committee that a similar device on a minor scale is now in use in "hot" laboratories—those using radioactive materials.

The satellite's robot would enable the operator to see problems as they arise, and then solve them.

"When such devices are well developed," Whipple told the committee, "they will have multitudinous practical purposes on earth. I can see the time when the telepuppet will do our dangerous mining underground . . . and also deep sea operations."

Hollow Titanium Shapes Now Cold-Extruded

The first successful cold extrusion of hollow titanium shapes—a major step in the development of economic methods for producing hollow aircraft parts —was reported to the Manufacturing Methods Branch of the Air Materiel Command this week by Battelle Memorial Institute. The work was performed under a development contract awarded by AMC's Manufacturing Methods Branch.

Cold extrusion of hollow shapes is the latest accomplishment resulting from studies conducted during the past two years for the Air Force by the Columbus, Ohio research center. This research, which has taken cold extrusion of titanium from a laboratory concept to the threshold of commercial application, was conducted by the institutes' light metals staff under the direction of Paul D. Frost and Alvin M. Sabroff. This was the same team that first reported success in the development of a technique for hot extrusion of titanium, also while conducting research for the Air Force.

One unique aspect of this cold extrusion research was the use of a 700-ton hydraulic press.

In cold working titanium for the Air Force, Battelle metallurgists pro-

duced hollow titanium shapes by forward and backward extrusion. One-and-one-half inch diameter slugs of unalloyed titanium were backward cold extruded in a three-story high hydraulic press to make cups up to three inches long with wall thickness down to 0.22 inch. This is a 50 percent reduction in thickness.

In forward extrusion studies, cup-shaped billets with 1½-inch outside diameters and 7/8-inch inside diameters were cold-extruded into cylinders with wall thicknesses down to 0.15 inch. Surface finishes were 30 to 60 micro inches, equivalent to a smooth turned finish. In addition to providing a finished surface, cold extrusion improves mechanical properties of unalloyed titanium. Increases in tensile strength of 30 percent have been obtained.

Air Force, Army Begin Missile Systems Training

The Air Force has announced start of a comprehensive missile system training program for the *Atlas, Titan, Thor, Jupiter, Snark, Mace-Matador and Bomarc.*

Air Force training will be at three command bases: Chanute Air Base, Ill.; Lowry Air Base, Colo.; and Amarillo Air Force Base, Texas. Two additional bases, Keesler in Mississippi and Sheppard in Texas, are scheduled for training programs in the near future.

The Army Ordnance Guided Missile School, Redstone Arsenal, will begin classes on the 20-mile range surface-to-surface missile, *Lacrosse.* Some 32 students are enrolled in three *Lacrosse* classes and will receive instruction in maintenance supervision, guidance system repair, and electro-mechanical repair.

SAC will be responsible for crew training in the *Atlas, Titan, Thor, Jupiter* and *Snark* systems. TAC will have crew training in the *Matador-Mace,* and ADC will be responsible for *Bomarc.* Courses will run from two to 30 weeks.

m/r Columnist Receives 2nd Award in Two Months

The second honor in two months was bestowed on Dr. Hubertus Strughold, dean of space medicine and m/r columnist.

Dr. Strughold was presented with the Theodore C. Lyster Award at the recent Aero Medical Association meeting in Washington, D.C. "for his outstanding achievements in the field of



In one practical instrument, CEC's 6-201 Primary Pressure Standard offers an extended range of precise pressure measurements available in no other similar equipment. Operating as a pneumatic dead-weight tester, the 6-201 offers the advantages of air rather than oil as the pressure medium, extreme accuracy of 0.015% of full range even at pressures of less than one psi, cleanliness and portability regardless of the pressure range. Because this flexible gage or absolute-type instrument depends only on mass and length measurements for its accuracy, it is a true primary pressure standard. It will calibrate any pressure-measuring device. Simple combinations of piston-cylinders and weights provide six pressure ranges within the limits of 0.3 to 500 psi, each with increments of 1%, for both gage and absolute measurements. For additional information, call your nearest CEC sales and service office, or write for Bulletin CEC 1581-X10.



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aviation and space medicine."

Formerly advisor for research to the commandant of the USAF School of Aviation Medicine, Dr. Strughold has recently received the Air Force Exceptional Civilian Service Award.

Brig. Gen. M. Samuel White, Air Force flight surgeon and Director of medical staffing and education in the Surgeon General's office, was installed as the new president of the association.

Captain Miller To Head Pacific Directorate

All activities concerning the development and operation of the new Pacific Missile Range will be under the control of a Directorate headed by Captain Walter B. Miller, U.S.N., formerly Deputy Director of Tests at the Naval Air Missile Test Center, Point Mugu, Calif.

The range, which will be the nation's largest missile test range, will be utilized by all three services under an arrangement similar to that in effect at Cape Canaveral and the Army's White Sands Proving Grounds. Both shore-based and ship-based instrumentation will be used.

DuMont Instrumentation Controls Nuclear Plants

An instrumentation system to be used in proving nuclear reactor design, will be incorporated in training programs for personnel serving aboard the Navy's nuclear-powered submarines.

Developed by Allen B. DuMont Laboratories, the instrumentation will be used in a land-based prototype of a nuclear sub plant developed by General Electric for the AEC.

The system monitors nuclear reactions continually and indicates rate of change of neutron flux from "start up" to "full power," incorporating instantaneous shutdown when the upper safety limit is reached.

Defense To Standarize Specification Drawings

A single specification for procurement of engineering drawings to become effective within a year is the latest aim of the Defense Department. As of now, engineering drawings are prepared in accordance with about 28 different specifications.

James H. Mars, assistant to the chief engineer of the Navy's Bureau of Ordnance, is chairman of the Armed Services Ad Hoc committee. A series of meetings are being held in which

both industry and the Armed Services will participate, in an effort to get satisfactory single specifications.

One such meeting will be held at Wright-Patterson Air Base on May 27 and 28. About 25 representatives of industry will attend; including representatives of Aircraft Industries Association, American Ordnance Association, Electronics Industries Association, National Security Industrial Association and Society of Automotive Engineers.

Col. C. M. Howze, chief of the Cataloguing and Standardization Branch of AMC's Directorate of Supply, will be the host at the meeting. Members of the committee at Wright-Patterson AB include: Daniel J. Bennett and Russell Eaton of AMC; Frances D. Floto and A. G. Adman of Wright Air Development Center.

New Army Reserve Unit To Study Rocket Projects

A new and somewhat unique Army Reserve unit was formally organized at the Sacramento plants of the Aerojet-General Corp. last month.

The 6501st U.S. Army Reserve Research and Development Unit will enable reserve officers to earn credits by working on projects connected with rockets and the logistical support of rockets and missiles.

Lt. Col. C. W. Hash, senior advisor to the Army Reserve in Sacramento, reported that the rocket research and development project will help Army reservists broaden their technical knowledge of missiles, and acquire know-how that will be useful in the event of active duty.

The unit will consist primarily of men employed at Aerojet and nearby military installations.

Douglas Organizes Group To Plan Space Program

Key scientists and engineers of Douglas Aircraft Co. have been named to a special planning group to chart the Company's participation in space flight.

Reporting to A. E. Raymond, engineering vice-president and head of the company's recently-formed Engineering Council, will be M. W. Hunter, R. B. Canright and Dr. W. B. Klemperer, Missiles Engineering; P. R. Compton, Long Beach Division; Dr. E. B. Konecci, Tulsa Division; H. T. Luskin, Santa Monica Division; A. M. Mayo, El Segundo Division; and C. E. Pettingall, Testing Division.

The group will investigate basic fac-

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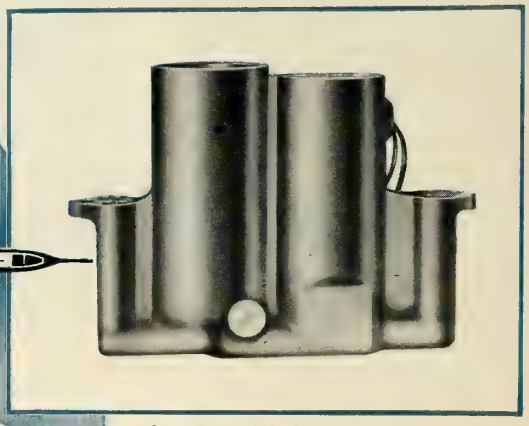
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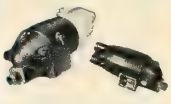
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tors in space programming and weigh merits of space flight proposals.

ASME Materials Handling Session In Cleveland

A space and atomic age session in materials-handling engineering will be held in Cleveland, June 12. The session will be on the agenda of the American Society of Mechanical Engineers meeting.

The ASME materials handling conference is being staged in connection with the National Materials Handling Show, June 9-12.

Erik Bergaust, m/r executive editor, will be chairman of the special session. Featured speakers will include: Michael Mastracci of American Machine and Foundry Co., New York, and Col. Leonard Winget, Corps of Engineers, Research Development Laboratory, Fort Belvoir, Va.

Topics discussed will include "Operations Research in Materials Handling;" "New Developments in Materials Handling;" "Design and Development of Special Equipment," and "Missile and Space Age."

Falcon Model Presented To Smithsonian Institute

A production model of the first operational air-to-air guided missile, the Hughes *Falcon*, was presented recently to the Smithsonian Institution, Washington, D.C. Senator Goldwater (R. Arizona) made the formal presentation.

The display of the *Falcon* missile, produced for the Air Force by Hughes Aircraft Company, Tucson, Arizona, will be exhibited in the National Air museum, where a permanent rockets and missiles section will be established.

IGY Rocket Probe Achieves Atmosphere Data

The National Academy of Sciences' IGY Committee has completed a successful season of rocket probings of the upper atmosphere at Fort Churchill, Manitoba, Canada, with the launching of 41 rockets since July. Firings will be resumed in mid-June with 32 more launches scheduled.

Twenty-two of 23 rockets fired this year produced desired scientific data. Rocket vehicles used and planned for probes between 46 and 160 miles out include the *Oki Phase II-Dart*, the *Nike Cajun* and *Nike-Asp*, and the *Aerobee* and *Aerobee-Hi*.

Data accumulated is expected to

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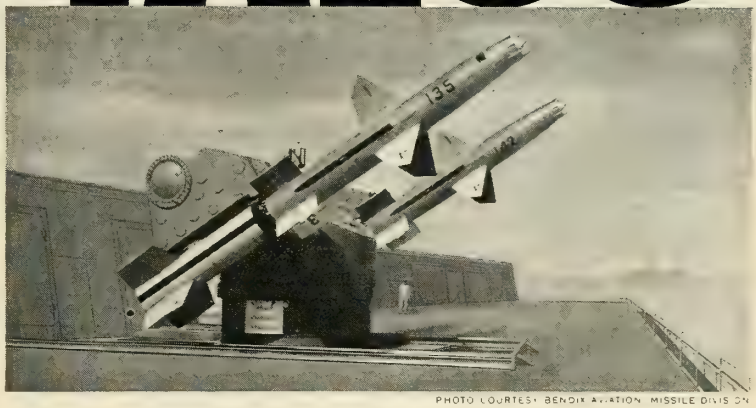


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GIANNINI'S MODEL 3416 FREE GYROS MAN THE HELM IN THE NAVY'S TALOS. Mid-course guidance of the TALOS missile is achieved by riding a radar beam to the vicinity of the target. Immediately after launching, aerodynamic considerations require the missile to fly a *straight and narrow* path, maintaining constant attitude. Giannini Two-Axis Free Gyros have been piped aboard the TALOS to hold it "steady as she goes!"

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give new information on the altitude of the electric currents responsible for disturbances in the earth's magnetic field during an aurora.

Information will also be acquired on the nature, extent, and location of electrons and ions at high altitudes which govern radio transmission.

Sputnik III Scheduled For May Day Celebration?

According to informed sources, the Soviet Union had tentatively scheduled the launching of *Sputnik* III for May 1, in celebration of the communist party's traditional holiday.

The satellite was to be as large as, or larger, than *Sputnik* II, and would contain instrumentation and experiments greatly superior to the first two Soviet satellites.

The most spectacular single experiment planned for *Sputnik* III is an attempt to create living matter through the action of cosmic rays on inorganic material. The experiment will utilize a mixture of ammonia, methane, steam, and carbonic acid.

It is expected that this mixture will reproduce, as closely as possible, the composition of the earth's atmosphere at the beginning of the first era. The action of cosmic radiation on this material is expected to verify or disprove Soviet and American hypotheses concerning the origin of life.

Other reports indicate that the Soviets are training another small dog, "Alpha", for flight in *Sputnik* III, and are working on a method of recovering the dog from its orbit.

A hermetically-sealed space cabin will be fitted into the main structure of the satellite, utilizing retro rockets and drag devices developed by the USSR to reduce the velocity of the cabin as it reenters the atmosphere.

After ejection of the dog's cabin from the main satellite, *Sputnik* III will continue in its orbit and may possibly use solar batteries for longer transmission-life of its equipment. Specific electronic, cosmic, X-ray and solar radiation experiments will be more refined than those incorporated in *Sputnik* II, Red advisers say.

EIA Contracting Program Will Tour the U.S.

A "Methods of Contracting" symposium, sponsored by the Electronic Industries Association, was held in Washington on April 22.

The one-day meeting, attended by nearly 80 member company representatives, was held by the Military Systems Management Committee (formerly Guided Missiles Committee), under the chairmanship of F. R. Lack, who is a vice president of Western Electric Co.

The principal speakers at the meeting were:

S. C. Donnelly, Assistant Works Manager, Western Electric Co., who discussed "Prime-Subcontracting methods of procurement on Defense contracts"; James D. McLean, President of Hoffman Laboratories, who spoke on "Group Contracting"; and W. M. McFarland, Executive vice president of Hazeline Corp., who spoke on "Leader-Follower Contracting."

The meeting evoked such interest that the committee is now considering a repeat of the program in some of the major electronic centers throughout the U.S.

Thor-Vanguard Shoot Not Classified as ICBM

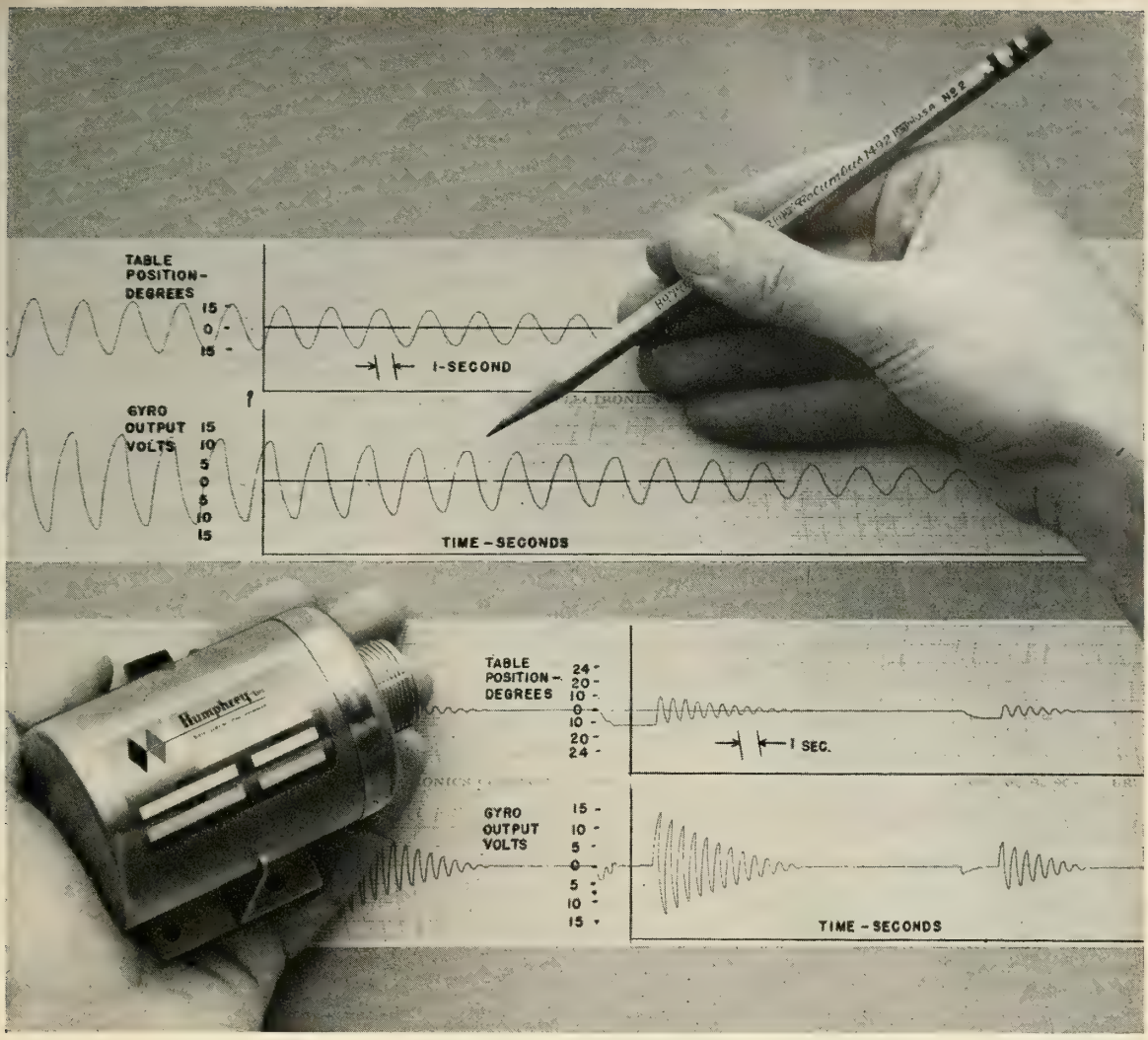
Despite repeated urging by a member of the House Committee on Astronautics and Space Exploration, Maj. Gen. Bernard A. Schriever refused to classify the April 23 *Thor-Vanguard* shoot as a successful ICBM launching. (For more information on testimony before Congress, see also p. 50 of this issue.)

The Air Force missile chief explained that to be classified as an ICBM, it would be necessary to employ "more discreet guidance" and different weight-carrying capabilities. Schriever, at the time of testimony, said it would be about three days before detailed information concerning the launching would be available.

The Air Force later called off Navy picket ships searching for the nose cone, which came down in the Atlantic about 6,000 statute miles away from Cape Canaveral, according to best military calculations.

General Schriever also commented on other subjects at the hearing, indicating that *Thor* is on schedule and that he believes the first squadron will be in operation in England by the end of the year.

He also stated that he is not strongly in favor of sending a man 150 miles up in a capsule. Schriever expects that in 15 to 20 years, man will be able to step into a rocket in New York or Washington and land in Europe 30 minutes later.



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Pershing Costs May Run $900 Million, Report Says

M/r has learned Army Ordnance's solid-propellant *Pershing* program possibly may run as high as $900 million and the timetable for production of the second generation missile is three years.

Pershing's test vehicle will have two stages; a 30-ft. length and a 24 inch diameter. Sources say the second stage, which will separate at about jet stream altitude, will have parachute recovery. A camera will be mounted in the final stage to take photographs within a four to five mile radius of the impact areas.

Such a small diameter indicates the Martin Company, prime contractor for the 500-700 mile MRBM, apparently will put design features of its pencil-shaped *Vanguard* structure to a new and improved use.

Warhead-wise, it probably will mean a payload meeting, or exceeding the Navy's 650-pound *Polaris*. The Army's 200-mile limit on allowable missile range has been relaxed, according to Army Secretary Wilber Brucker, to the extent that whatever range possible with *Pershing* can be Army's operational capability.

Martin's Orlando Division plant, the first missile industry facility under Army administration, will have complete systems responsibility for *Pershing*, although supervision will be by ABMA.

Award of the *Pershing* contract last month, worth several million dollars initially, to Martin Orlando—one of six bidding contractors—was a departure from the Army's practice of developing weapons at government arsenals rather than giving weapon system responsibility to a prime contractor. However, Martin has sales campaigned actively for more Army projects since establishing its Orlando Division, where Army's *Lacrosse*, and the *Missile Master* electronic control system are being produced.

Pershing, sources say, will be statically tested on Martin's 7,000-acre pine wood site south of Orlando. Flight tests, possibly in 24-30 months, initially will be at Cape Canaveral, Fla., about 60 miles from the Martin plant.

While no firm committment has been made on *Pershing's* two solid propellant engines, Aerojet-General Corp. and Thiokol Chemical Corp. reportedly are neck-to-neck.

Martin has a half-million square foot facility at Orlando, but with three weapon systems in production, they are feeling a space pinch. Further building expansion probably will be dictated by *Pershing*.

List Solid Booster Data for Holloman Test Track

ALAMAGORDO, N. Mex.—The Holloman track at Air Force Missile Development Center has released data on commonly used solid boosters. Although liquid-propellant systems with short burning times are available, liquids are recommended only for burning times in excess of 10 seconds and where 20 or more runs are to be made. The table presents data on solid units used at Holloman.

UNIT	THRUST (lbs.)	TIME (secs.)	LOADED WT. (lbs.)	EMPTY WT. (lbs.)
Loki	3,150	0.78	17.8	5.6
5" HVAR....	5,800	0.86	83.3	59.3
1. 8KS-7800..	7,800	1.8	118.0	48.0
2. OCS-10000	10,000	2.0	224.0	122.0
2. 2KS-11000	11,000	2.2	256.0	113.0
2. 5CS-18000	18,000	2.5	570.0	310.0
3. OKS-47000	47,000	3.0	1384.0	654.0
5. OKS-4500	4,500	5.0	236.0	111.0

Ballistic performance of solids are usually ±10% but control of specs can bring it down to ±5%. Careful conditioning of units to temperatures prescribed by manufacturers results in predictable performance to ±3% of rated thrust or less. The liquid unit in operation at this New Mexico track has the following characteristics:

Thrust, Preset (lbs.)	35,000 to 50,000
Propellant	LOX-Alcohol
Starting Wt. (lbs.)	3,200
Propellant Wt. (lbs.)	1,400
Burning Time (secs.)	up to 4.5
Maximum Velocity (ft./sec.) ..	1,800
Maximum Payload (lb.)	1,200
Acceleration (g)	4 to 11

Cold Box for *Nike-Hercules* Makes Weather for Testing

WHITE SANDS, N.M.—A mobile weather maker—costing $80,000—is now simulating hot and cold field conditions for the *Nike-Hercules*. The portable conditioner can reach temperatures of –100°F to 200°F. The designer is Guldemann Construction & Engineering Co. of El Paso, Texas. Actual fabrication of the unit—measuring 60 feet long, 14 feet high and 15 feet wide—was by another El Paso firm, P&R Truck Equipment Co.

Built in two sections, the box can completely cover the *Nike* while it is on its field launcher just prior to firing. It takes about two minutes to pull the two halves apart and fire.

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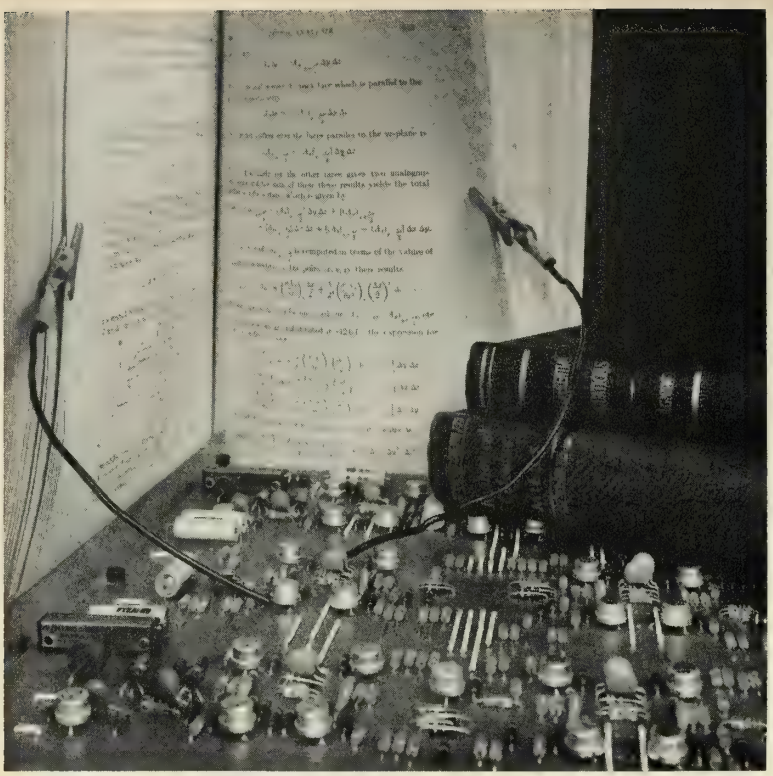
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m/r staff report on markets:

Most Missile Money Goes to Subsystems

MONEY FOR MISSILES is divided between the following kinds of contractors: prime systems, subsystems, components and vendors.

By far the largest of these breakdowns is subsystems; next, probably, components. Not only do Government contractors buy subsystems direct, but between 50 and 80% of all money placed as prime systems contracts funnels right through the prime contractor to subsystems and components equipment suppliers.

Though no precise over-all figures are available, this probably means that of the $3 billion to be spent on missiles this year, some $2 billion will be spent on subsystems and components. This total should hit $2.5 billion out of approximately $3.5 billion in Fiscal Year 1959, and over $4 billion out of about $6 billion in 1960. Missile research and development is something else again and is carried in separate fiscal accounts.

Beyond 1960, the sky (literally) is the limit, and it's anybody's guess as to what that limit is. Least of all do top Defense Department budget planners know how big the rockets, missiles and space flight tab will be in 1961 and after. Nor will they, until the present period of elementary soul-searching and decision is completed—probably along about next fall, in time for working up the fiscal 1960 budget requests.

All of these figures are applicable only to missile and immediately-related procurement. They include *Polaris*, but not the launching submarines. They include *Bomarc* plus launchers, etc., but not the actual construction of the bases—a considerable sum in itself.

They do not include that portion of research and development that goes for missiles—perhaps half the $2 billion slated for fiscal year 1959.

Nor do the budget figures stated earlier include all of the ground-based electronics required for missiles and missile support. The Pentagon does not give out missile share of these figures. But it's a safe bet that a healthy portion of the $864 million allotted to "electronics and communications" in 1959 will have to do with missile subsystems. Add in these items and you can figure on another $1-to-$2 billion in missile-related procurement.

• **Place in the industry**—Subsystems and components cover that mammoth area of the missile market between the prime systems contractor and the vendor—without them the former would not have a product, and the latter would not have much of a market.

Most subsystem contracts are placed by prime systems contractors, though when a missile reaches the production stage, the government also becomes an important customer. In the case of the Air Force's big ballistic missiles, all subsystems contracts, even at the research and development stage, were placed as prime contracts by government procurement.

Normally, however, the company with systems responsibility places all contracts for the completed missile system; at least this is true up to the point where the "bird" goes into volume production. At that point the government may or may not take over responsibility for placing subsystems contracts on a "negotiated bid" basis. The practice seems to vary arbitrarily.

• **Definitions**—A subsystem is a major working part of the missile; a component is a working part of that subsystem. Thus the component—a complete-but-empty solid rocket motor casing, for instance—becomes a subsystem once it's loaded with propellant and ready to be integrated into the missile. In another case, an inertial reference platform is a component of an inertial guidance subsystem.

By one definition (and these vary both in industry and government) the typical subsystems include:

Payload (warhead), guidance, control, auxiliary power unit, propulsion, missile body, ground support, ground handling gear and launching equipment.

In turn, these break down into components like this:

PAYLOAD is made up of container, explosive (if that's its mission), and fusing mechanism.

GUIDANCE consists of a position locator (radar, radio, infrared, sound, inertial reference platform, celestial

triangulator, etc.), computer (which may be missile-borne, ground based or both) and instructor circuits.

CONTROL has two major components: transmission (hydraulic, electrical or mechanical) and controller, such as movable aerodynamic fins-vanes placed so as to deflect the rocket exhaust gases, a gimballing system on a liquid propellant engine, special auxiliary jets powered by steam (H_2O_2), or rocket exhaust to control roll, pitch and yaw.

In addition, there are thrust controllers, engine cut-offs, stage separators, and flow-metering circuits.

The auxiliary power unit supplies power for guidance and control. Its components break down into a hydrogen peroxide generator; a small rocket motor or a bleed-off system from the main rocket exhaust; turbine; alternator; and hydraulic pump. Or, if it's battery powered, batteries replace the high velocity gas source and turbine assembly.

Except for air-breathing missiles, which use ramjets or conventional turbojets, propulsion divides between liquid and solid propellant rocket motors. Components for solid rockets consist of casing, liner, resonance rods (if any), igniter and of course the charge itself—a polymer-bound mixture of oxidizer and fuel. Liquid engines are more complex. They include: fuel and oxidizer tanks, pumps, valves, injection head, combustion chamber, and nozzle assembly.

• **Airframe and support**—The airframe may be ribbed, skinned and riveted (as with aircraft), but more often it's machined and welded, either of steel or aluminum and—rarely—of plastic.

Airframe, in this definition, also includes the nose cone, which may be machined from a heavy forging and coated with heat resistant material to enable it to withstand the high heating rates of reentry into the earth's atmosphere; or it may have to be transparent to infrared and radar and thus be of plastic or glass.

GROUND SUPPORT equipment includes such components as: Liquid oxygen generators, ground-based computers, check-out gear ("go, no-go boxes"), ground-based computers, radar, telemetry receivers, fuel trucks, pumps, fire fighting equipment, protective clothing, cherry pickers, pressurized nitrogen and helium transporters, electric blankets (to keep solid propellant rockets warm in winter), and portable electric generators.

GROUND HANDLING equipment is the gear that actually handles and moves a missile about. This may be a gantry crane, a dolly, a tractor-trailer combination, various special fittings, etc.

LAUNCHING EQUIPMENT is the launcher that holds and positions the missile for firing. Its components would probably include a hydraulic system, power supply, launcher and blast deflector equipment.

Generally speaking, ground support, ground handling and launching are lumped into a single generalized equipment category.

In addition to these various individual items of hardware, with bigger missiles such as ICBMs, and with anti-aircraft missiles like *Nike* and *Bomarc*, there is a considerable amount of site construction—calling for such things as reinforced concrete, roads, underground storage tanks, buildings, and hangars.

And with each individual missile system, there are always a few unique problems, depending on whether the bird is big or small; whether it's air-launched, ground-launched or ship-launched; whether it's a fixed base item or is mobile; whether it needs to be air transportable or air dropped.

Take *Polaris*, for example. With any long range ballistic missile, the precise location of launch, relative to target, must be known in order to feed in proper guidance instructions. *Polaris* will be launched from a submarine. So in addition to everything else, every *Polaris*-launching submarine will have to be equipped with a highly complex and costly system known as SINS—Shipboard Inertial Navigation System—in order to fix its position.

It's tough to separate markets. No one in the Army, Navy, Air Force, Advanced Research Projects Agency or the Department of Defense has yet been able to "break down" missiles—as to industrial requirements per program, flow and distribution of money to and through industry, their total impact on the economy. In other words, there is no easy way to determine who's got the money, which subsystems get the most money, just where the most lucrative markets are.

• **Ways to figure**—However, there are enough individual examples floating around to enable an enterprising salesman to draw his own conclusions.

No two missiles are alike, but a very rough break-down of how the missile system money is distributed to the various subsystems goes like this:

Missile-borne electronics and guidance, 20%; control, 5%; payload, 15%; propulsion, 10%; ground support, 15%; ground handling, 10%; launching, 10%; airframe, 15%. In the larger missiles (to which these figures apply) the cost of an auxiliary power unit in production runs less than 1%.

From another viewpoint, recently released figures for a 10-bird operational *Atlas* ICBM base, state that the 10 missiles on site will represent less than 20% of the total cost. Almost 40% will be in ground-handling, support and launching equipment, 10% in spare parts and 30% in what the Pentagon calls "technical facilities."

Actually, if you add up all the electrical-electronic gear in a missile system you'll often come up with a value of over 50% of the whole system.

Take *Thor:* this bird now costs about $1 million. Its missile-borne guidance accounts for about $250,000 of that—though hopes are to get the price tags down to $750,000 and $190,000 respectively. Present cost of guidance for *Jupiter* is also $250,000. A launcher for a *Bomarc* costs between $45,000 and $65,000, depending on who is bidding.

An empty *Nike* booster case costs something under $1,500. A machined magnesium housing for an autopilot electronics package may run $200-to-$300. A wave-guide for checkout balance system may run $35; a thrust sustainer cone, $3,900. A small solid propellant motor, such as *Recruit* can be had, off-the-shelf, for under $1,500. Its bigger brothers, such as *Polaris'* main stage propulsion unit, will run to many thousands of dollars.

• **Who buys**—As to who the customers are—the answer can be almost anybody.

All told, there are two-to-three dozen prime systems contractors scattered all over the country.

According to Courtland S. Gross, President of Lockheed Aircraft Corp., of 43 missiles of all types, West Coast companies are involved in 25 and have prime contracts on 14. Convair-Astronautics spends up to 70% of its missile money outside of the division. One estimate is that Convair-Astronautics will spend $92.3-million this way in 1958. Boeing also subcontracts out 70% on the *Bomarc*, including all ground support equipment. Raytheon Manufacturing Co. subcontracts all ground support and propulsion on the *Hawk*.

Ford Instrument Co., a division of Sperry-Rand, subcontracts 75% of its work on *Jupiter* guidance outside of the division and 35% outside of the company entirely. AC Sparkplug division of General Motors figures on spending 50% outside of its own plant in its work on *Thor* guidance.

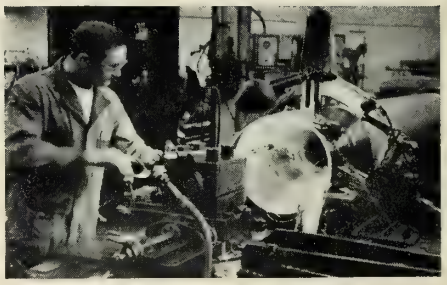
This, in brief, is the missile subsystem and component market.

It is big and getting bigger.

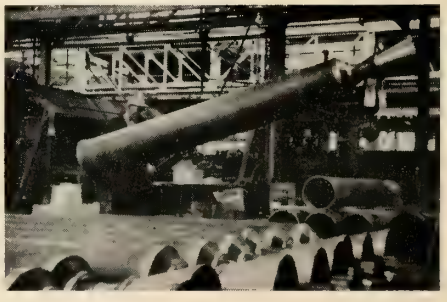












Photography by Seabrook Hull

COMPONENTS in production

IT TAKES A LOT TO MAKE A MISSILE—a lot of man-hours, facilities, steps, skills—and lots of money. Bits, parts and pieces are made from basic stock; these are put together and become components; components, assembled, become subsystems; and subsystems become weapons systems. On these two pages are components in the making.

The totem-pole series of pictures to the immediate right begins with a missile piece being forged at Ladish Company. Moving down the column, the aft closure forging of a *Nike-Hercules* sustainer comes out after shot-cleaning—ready for rough machining. Next, a machinist at the Ingersoll-Kalamazoo division of Borg-Warner Corp. does final truing up of a *Nike* booster casing after heat treating. Then, a Government inspector uses special equipment to check dimensions and tolerances. And finally, the completed *Nike* sustainer is carefully transported to the paint shop.

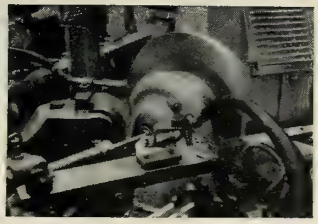
The unusual pattern in the picture to the top left of this page might be entitled: "So you think you know rockets!" A few readers will recognize these structures as resonance rods to stabilize the burning in a solid motor.

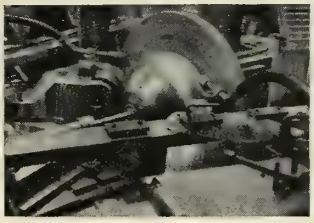
For another pattern in missilery, note that photograph to the lower right of the page opposite. This sparkling array of *Nike* sustainer casings is dramatic proof that today the missile is indeed a production item.

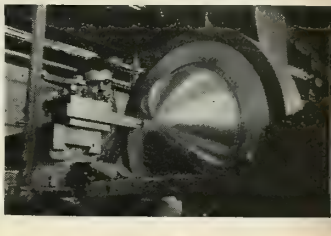


Just as the research and development of rockets and missiles brought forth whole new sciences and technologies, so does their entry into production bring changes and improvements to the assembly line. Here, through a marriage between hydrospinning and precision machining, time and dollars are cut from the cost of a nose section for an IRBM. This production technique holds great promise for the manufacture of even larger one-piece missile sections. This technique is applicable to hemispherical shapes, nose cones, nozzles, and even large rocket casings. Virtually any metal from aluminum through the range of the high temperature alloys is susceptible to this approach. These pictures were taken at Diversey Engineering Company who, along with Borg-Warner and General Electric's Rocket Engine Section, is pioneering hydrospinning.









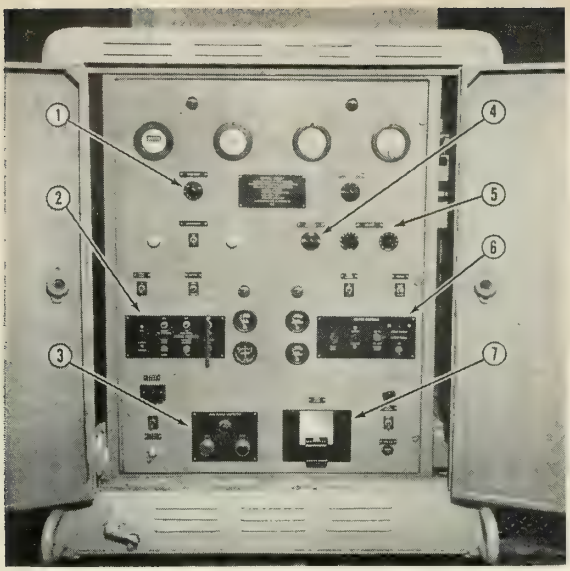


Closer tolerances in the production of large metal sections are called for in rocketry than ever before has been required of a mass production industry.

To the left, a final check of finish and dimensional tolerance is made before shipment of the IRBM nose section. The picture at lower left shows another vital step in the production of a large solid propellant motor. Here, the core mold that will define the rocket's burning area is being machined on a Monarch air gauge tracer lathe. This is a touchy operation: the mold is machined from solid stock of the highest quality. If at any point too much material is taken off, the piece must be discarded. Such requirements are commonplace on missile assembly lines. Rejections are few—a real credit to American industry.







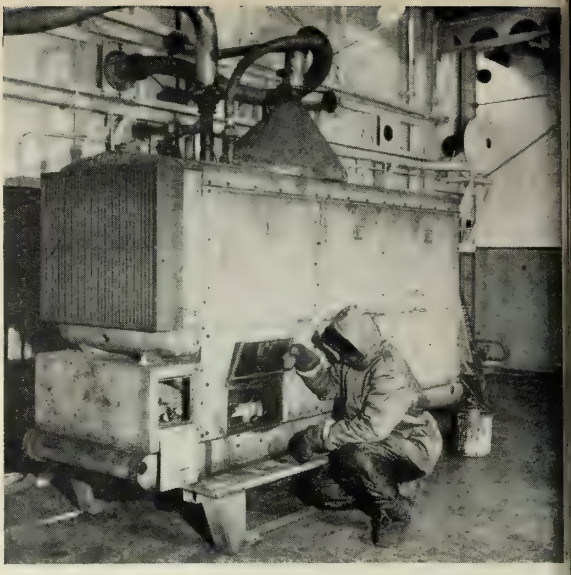


FIG. 1 AND 2—End view of diesel-powered electric set control panel showing: 1) Speed droop control 2) Engine controls 3) Main power contactor 4) Voltage reference 5) Line droop compensation 6) Heater controls 7) Main power circuit breaker (left) An electric set is shown (right) undergoing testing in a "cold room" facility.

Diesel Units Power Ground Support

by J. H. Ashton*

IT HAS BEEN SAID that more money is spent on ground support equipment than on missiles themselves. This may be an exaggeration, but it does point up the growing importance of ground support equipment in the military weapons system.

The switch to jet aircraft, with their electronic navigation and fire control systems, required ground power units to be changed from low voltage dc to 400-cycle ac. This reduced the size and weight of airborne gear and eliminated low voltage power line loss. The switch to missiles, demanding high accuracy, increased operating speeds and extended range of operation have expanded these requirements. Quality power is directly reflected in higher quality components requirements for using independent ground power units.

There are three basic reasons for using independent ground power units. They must be able to operate independently of utility power sources, since utility power stations, substations and transmission lines are extremely vulnerable to sabotage.

The units must be mobile to permit missile sites to be moved swiftly from one location to another for evasive actions.

There is also the need for more precise control than is available from utility power sources.

A diesel-driven electric unit that provides power at calibration and during firing standby for the *Snark* missile is shown at upper right. At the time of launching, the diesel electric unit is operated in parallel with the missile's internal power supply. Accuracy of the missile will depend upon the accuracy of calibration and the calibrating power unit. The calibration margin of error becomes more critical as the range of the missile and speed of operation is increased.

• **Unit Power Requirements**—Procurement specifications for the diesel-powered electric set used with the *Snark* missile require that the unit be capable of:

1) Rating of 60 KVA at 0.8 power factor (48 KW—capability of 60 KW), 120-208 volt, 3-phrase, 4-wire, 400-cycle. Speed of operation 1714 rpm, approximate weight 6000 lbs. without undercarriage.

2) Amplitudes of all harmonics (peak values) not to exceed 2 per cent of the fundamental amplitude at no load, half load and full load.

3) Voltage to recover and remain within one per cent of rated value in 0.15 seconds or less under full load application or rejection. A voltage transient not to exceed a band between 108-121 volt range for more than 1.25 milli-seconds with the nominal voltage set at 115 volts for a 25 per cent load variation. Under full load transients, the frequency must stabilize within 1.5 seconds, with the speed not exceeding a plus or minus three per cent of rated speed.

4) Voltage modulation must not exceed one per cent from zero to full load with per cent of modulation defined:

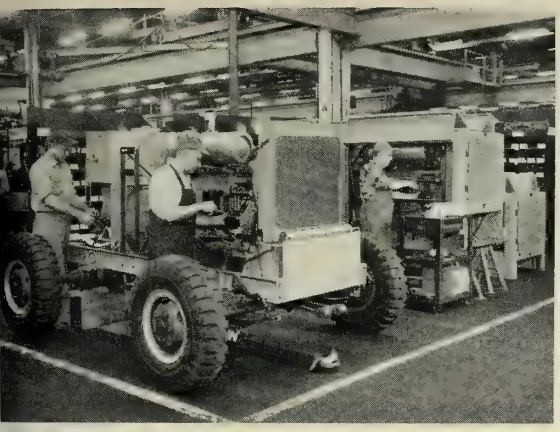
$$\frac{\text{Emax.} - \text{Emin.}}{\text{Emax.} + \text{Emin.}} \times 100$$

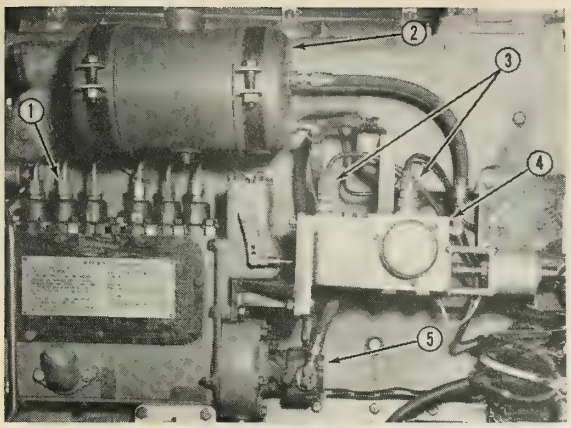
5) Output frequency to be within a band of ± 1/3 of one per cent of all stead-state load conditions from zero to full load.

6) Unit to be winterized for starting and operation at –65°F.

7) Must have local and remote control operation of frequency and voltage.

Manager, Engineering Engine Division, Caterpillar Tractor Co.





IG. 3 AND 4—The final assembly line in the Caterpillar electric set manufacturing plant (left). Wheel and skid mounted 400-ycle units are produced on parallel lines. Closeup of fuel system (right) 1) Fuel injection pump 2) Hydraulic fluid reservoir) Hydraulic servo and governor electrical connections 4) Hydraulic servo 5) Hydraulic pump

8) Provide line group automatic ompensation for any combination of esistance and reaction drop up to ten er cent.

9) Provide voltage sensing at either ocal or remote terminals.

10) Electric set to be skid-mounted ith provisions for trailer under-car-iage and running lights.

11) Unit to be designed for all nvironmental conditions including igh and low temperature, humidity, ltitude, salt spray, fungus, rain, sand nd radio interference.

•**Diesel Operation**—The diesel en-ine power package can meet most issile requirements, and is constantly eing improved. An example is the old-room tests performed in a con-nuing effort to improve the operating mitations of the engine (Fig. 2).

In a diesel engine, fuel metered into ne combustion chambers provides fast esponse after a load change is in-icated by the governor. Fig. 5 shows ne operation of the fuel injection quipment. A close-up of the mounting f the hydraulic components of the overnor is shown in Fig. 4. Interior nd exterior views of the electrical ontrol panel are detailed in Fig. 1.

In addition to the requirement for ortable electric sets, there is also a equirement for stationary power units. hese units are used in fixed missile stallations and for support of de-elopment programs, such as com-unication requirements and down-nge missile tracking stations.

•**Production Development**—Diesel ectric units are procured late in the evelopment period of the missile sys-m, since most of the individual stem requirements are not known ntil their development is complete. urthermore, it is impossible to deter-mine early in the program the quantity and quality of power that will be required. Thus the manufacturer must guarantee performance with an extremely short lead time prior to actual production.

A number of electric sets, in various configurations, are currently being supplied to the missile support market. Increased activity in the development of both offensive and defensive weapons systems will greatly expand the market for diesel electric sets and other diesel powered support equipment. Each missile system will undoubtedly have individual requirements which will prevent any great degree of standardization.

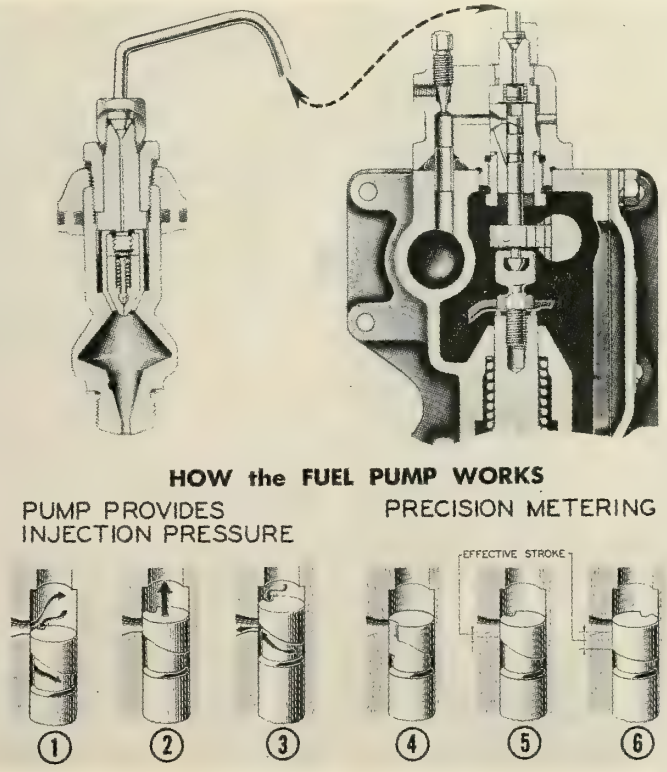
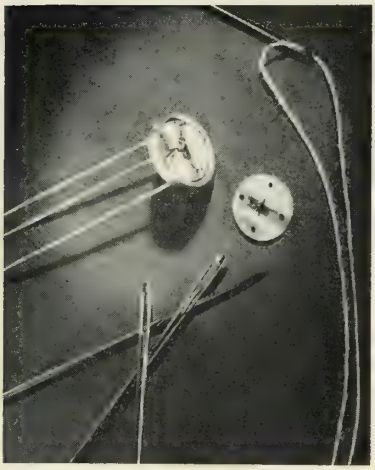


FIG. 5—Schematic of fuel pump operation. 1) Pump fills 2) Injection begins 3) Injection ends 4) Shut off 5) Idling 6) Full load

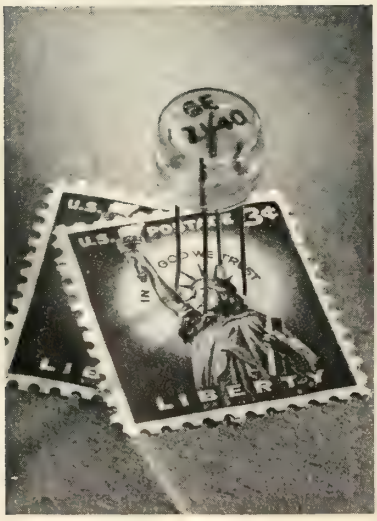
An m/r Missile Component and Products Survey:

Tiny, Rugged—and Vital to Missiles

by Frank McGuire







One highlight of this year's IRE show was the variety of new ideas in the transistor field. Transistors rugged enough to be shot from a 12-guage shotgun (upper left) were displayed by the General Electric Company. The extreme ruggedness achieved with these units stems from a newly-developed mounting of a germanium or silicon bar. Instead of suspending the germanium or silicon between upright posts in the conventional manner, GE mounts the semiconductor on a flat, circular, ceramic wafer. The wafer rests solidly on the base of the transistor housing.

Delco division of General Motors showed a new high-power, high-frequency transistor (center left) featuring a maximum collector voltage of 80 volts, low leakage current, and high temperature characteristics. At 25°C, the collector cutoff current for 60 volts is only 2 ma maximum, and at the important operating point of Vc= 2 volts, the collector cutoff current is 50 microamperes maximum.

Two new developments in all-glass housings were shown:

General Electric displayed i package claimed to be the first i meeting the TO-9 outline dimensio standard for low power signal tran sistors recommended by the indus try's Joint Electron Tube Engineer ing Council (bottom left).

Corning glass works introduced i two-piece transistor case (botton center), with case pieces hermeticall sealed at 1000C, while temperature near the semiconductor element ar kept in the region of 150C. Curren production is limited to the 200 m lead circle type, but Corning claim that other sizes will be available i the future.

Another product displayed b Corning was a fused silica crucibl for melting silicon, germanium an other semi-conductors where ex tremely careful control of purity i required. The new crucibles (botto right) are made by automatic pro duction methods from fused silica; pure silica glass with impuritie measured in parts per million or les





n silicon crystal growing, this glass s used in temperatures near 1450°C. The crucibles are being made in sizes ıp to two and one-half inches diam-ter and three inches long.

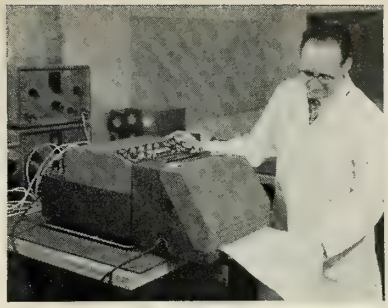
Consolidated Electrodynamics has leveloped a new instrument in the scillographic field, the Datarite (top eft), a combined magazine-and-rocessor which allows a test en-ineer to view test data a split sec-nd after it has been produced. By neans of a revolutionary processing echnique, the new unit provides de-eloped and dried photographic rec-rds as fast as the recording oscillo-graph registers the data.

Two models of the Datarite fit Consolidated's type 5-114 and 5-119 ecording oscillographs without modi-ication of any kind. The flash-pro-eeded record emerges from Datarite mmediately, and the traces are in-tantly visible as the record leaves he slot. After fixing, quality is equal o conventionally-processed records. However, fixing is unnecessary as the ecord will become stable in a few lays without further processing.

Another new product, a highly nique 3-layer motor shield (top ight) to attenuate magnetic and elec-rostatic noise, was displayed by the Magnetic Shield division of Perfec-ion Mica Company. The shield at-enuates both high and low frequen-ies at high and low intensities, per-nitting miniaturization of servo, syn-hro and other small motor systems y confining the motors radiated oise.

Avco's Research and Advanced Development Division has now made t possible to transmit information at ither 1/50th or 1/20th of its record-ng time. This two-unit precision ape-recording communication system s called the Avcom Compressor-Ex-pander, model CEM-50-1 (second rom top right).

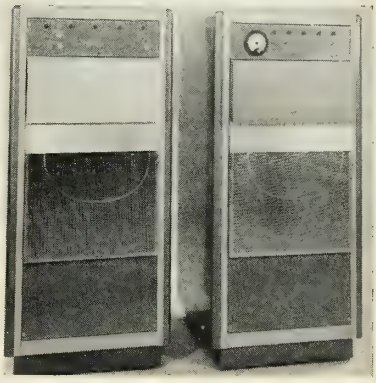
The unit allows high-speed trans-er of serialized digital information at 200 words per minute (20:1 com-pression ratio) occupying a band-width from 300 to 3000 cps. At 50:1 ompression, output of 3000 words per minute is achieved on a trans-





mission band from 750 to 7500 cps. These high-speed digital signals are recorded for direct operation of a standard teleprinter or tape puncher at a low-speed playout of 60 words per minute.

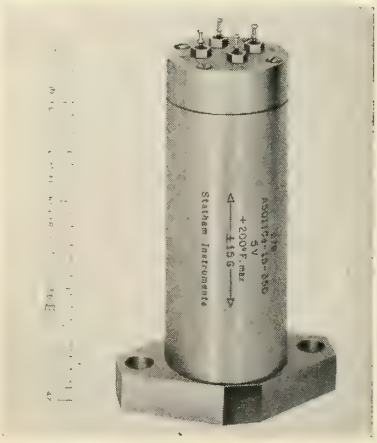
Corning Glass announced that it was now producing CY-type fixed glass capacitors with a full rating at 125 degrees C (third from top right). Meeting all MIL-C-11272A requirements, these capacitors are available with voltage ratings of 300V and 500V DC. Volume of the capacitors range from 0.005 cubic inches for the CY10 to 0.080 cubic inches for the CY30. For applications where extreme miniaturization is needed, capacitors with one-tenth the volume of standard CY types are attainable.



Statham Instruments Inc., announced the development of a new concept in the design of unbonded strain gage accelerometers. The use of gas damping, incorporated in the Model A501 accelerometer (bottom right), permits the operation of the device over a wide temperature range without the addition of a temperature jacket.

At temperature extremes, such as −65 to +200 degrees F, the useful frequency band of the A501 is approximately the same as that for a conventional accelerometer at room temperature. The new unit is offered in ranges from plus or minus 5 to 50 g's.





Other new products displayed by manufacturers include products shown on this page and on following pages of the New Products section. The theme of this issue is Components and Sub-systems.

This issue of m/r emphasizes the importance and variety of products which make up a missile and its associated equipment. There has been no attempt to make this report all-inclusive, in view of the rapid growth and diversity of the American missile industry. Because electronics and electrical equipment comprise the greatest portion of any missile system, these products are featured in this survey.

Electrical and Electronic

Waveguide Terminators Have Variable Adjustment

Polytechnic Research and Development Co., Inc. has developed a series of sliding waveguide terminations with frequency ranges from 2.6-3.95 kmc/s to 26.5 40 kmc/s, and a maximum vswr of 1.01.

These units consist of a tapered waveguide section in which is mounted a sliding low-reflection load attached to a plunger. The plunger is moved in and out of the waveguide section by means of a knob at the end of the guide. In this manner, the load position is variable through at least ½ wavelength at the lowest waveguide frequency.

This variable adjustment offers a distinct advantage in that it allows phase reversal of the residual reflection, so that this reflection can be separated from the other small reflections in the waveguide system. A locking screw allows the load to be fixed in any desired position.

In some types the load consists of a Synthane strip, while other types use a metallic film evaporated onto a Fiberglas base.

Circle No. 256 on Subscriber Service Card.

Two-Station Thermocouple Gauge Available

A two-station thermocouple vacuum gauge is available from the Rochester Division of Consolidated Electrodynamics Corp. The gauge, designated GTC-100, measures the total pressure in a vacuum system on a single scale. The non-linear scale is marked from 0 to 1000 microns Hg, with 5 microns the lowest indicated division.

The GTC-100 can be calibrated without the use of a reference gauge. It can also be used as a moderately sensitive leak detector throughout its range from 1 to 1000 microns. The TG-77 sensing tube cannot be harmed by exposure to atmosphere. Zero drift has been reduced by the use of lower heater current to decrease the rate of thermal decomposition of organic vapors within the tube.

The GTC-100 gauge, obtainable with one or two sensing tubes for use as a one or two station gauge, can be used with an accessory panel mounting kit. The gauge is 4⅞" high, 6½" wide, 3¾" deep and weighs 4½ lbs. Printed circuitry has been used to give a smaller more compact package than previous thermocouple models. It will operate from either a 115 or 230-volt power supply.

Circle No. 252 on Subscriber Service Card.

Waterproof Toggle Switch Has Simplified Mechanism

A waterproof switch has been developed by Control Products, Inc. This switch has a "stay-on, stay-off" feature similar to a toggle switch, without the conventional toggle switch mechanism.

The switch is completely protected against water and dust by being enclosed in a silicone boot that is permanently bonded to the silicone leads. It can be furnished in various lead lengths for other types of applications where there are severe water, steam, humidity, or chemical solution conditions.

Electrical rating is 15 amperes resistive at 115 vac with an expected life of at least 25,000 cycles.

Circle No. 239 on Subscriber Service Card.

Limit Switch Handles Extra-Heavy Loads

Two new small-size, two-circuit limit switches said to handle load capacities usually assigned to much larger limit switches have been announced by MICRO SWITCH, Division of Minneapolis-Honeywell Regulator Co.

One switch (designated ILSIO) has a rod actuator and is field adjustable through 360°, locking positively in any position. It can also be adjusted to operate in either or both directions. The head assembly can be positioned in any of four directions. This switch can be used in applications requiring low force and special lever forms.

The second switch (designated 8LS1) has a flexible coil-spring actuator that permits operation from any direction except direct pull. Easily operated by large, irregularly-shaped objects, this type is well suited to conveyor and counting applications.

On both switches, complete sealing protects all moving parts from dust and moisture. The replaceable basic switches are rated at 10 amperes, 120, 240, or 480 vac; ½ H.P., 120 vac; 1 H.P., 240 vac; 0.8 ampere, 115 vdc; 0.4 ampere, 230 vdc; 0.1 ampere, 550 vdc; pilot duty rating, 600 vac max.

Circle No. 231 on Subscriber Service Card.

Solenoid Eliminates Mechanical Linkage

The Leetronics Co. has announced the development of a rotary solenoid embodying a new concept in solenoid design and providing true rotary motion from an ac or dc input without utilizing linkage.

A feature of the design is that the output torque and angle of rotation are easily selected and adjusted. They are changed by shifting two stops that limit rotor travel. These stops allow selection of any portion of the overall "Motoroid" torque curve and rotation that suits a design.

The Motoroid 100 Series Model is the first of a complete line. It is a medium torque model that provides outputs of up to 4 inch pounds.

The units are available in closed or open-frame type and in continuous or intermittent duty models with either left or right hand rotation standard. They have an operating temperature range of −65° to +300°F (special models up to 500°F).

Standard operating voltage is 110 V, 60 cycles ac. Other voltages and dc are available on special orders. The standard angle of rotation is 60°. Longer travels can be designed upon request.

Circle No. 234 on Subscriber Service Card.

Decade Counter Has One Microsecond Reset

Burroughs Electronic Tube Division has introduced a new megacycle decade counter with Nixie numerical readout tube. This is claimed to be the only decade counter with provision for resetting from new position to zero in less than one microsecond.

Designed as a companion unit to the decade counters types 101 and 102, whose counting rate is 10 kc and 100 kc respectively, this plug-in unit can achieve the highest speed counting

and resetting, while still making all 10 outputs available for print-out or other general purpose applications. The power requirements are 300 v—30 ma dc and 6.3 v—0.9 a ac. The unit features high reliability through the use of the beam switching tube. The Nixie indicator provides precise in-line figures visible at 30 to 40 feet.

Circle No. 243 on Subscriber Servce Card.

Event Recorder Features One Hundred Channels

Brush Instruments is producing a 100-channel event recorder which minimizes the amount of time, space and equipment needed to perform complex checkouts on critical systems and accompanying processes.

The instrument permits recording of 100 channels of sequential or operational information simultaneously—indicating any number of events pertaining to electrical or physical phenomena data.

The event recorder, Brush Model RE 3610 00, records static and dynamic data on a moving chart 12″ wide and 500′ long. A record of events, their duration and their time relationship to each other, appears on the chart less than one millisecond after the electrical current is switched through the stylus. The electric writing method provides reliable, dry and permanent charts.

Rapid response of the Event Recorder permits up to 500 signal changes per second. Instantaneous electric selection of eight standard chart speeds with on-site or remote operation, and a chart speed accuracy within one-fourth of one per cent of established speed at constant line frequency are among the instrument's features.

The device is designed for compliance with military specifications and may be mounted in any standard 19″ rack, table console or mobile chart. Net weight of the event recorder is 60 lbs.

Circle No. 232 on Subscriber Service Card.

Spectrometer Features Automatic Readout System

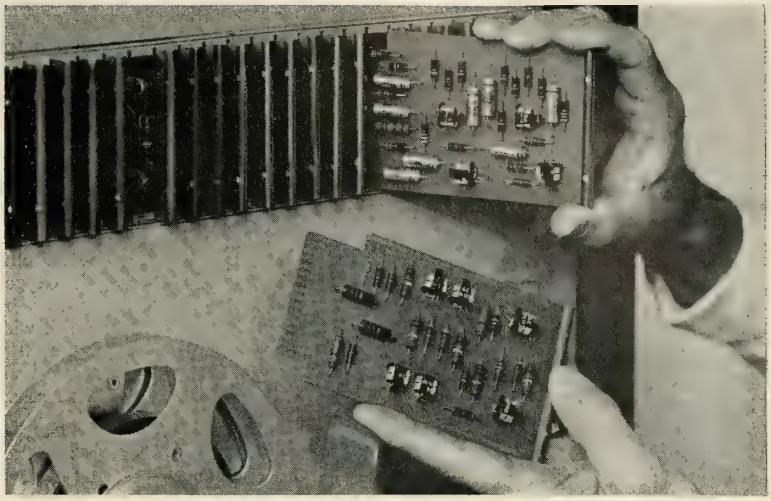
A Direct Reading Spectrometer with a completely automatic glow tube readout system has been developed by Baird-Atomic, Inc. A highly accurate analytical system to be used in conjunction with automatic data processing equipment, the B-A Direct Reader is equipped with an automatic glow tube readout system. This is the first unit of its kind to present information capable of being fed directly into electronic computers.

This auxiliary equipment permits the reader to perform 1080 determinations with complete data processing in about two hours. Prior to the automatic unit, 180 determinations with manual data transfer would require many additional hours.

The B-A Automatic Direct Reader provides simultaneous measurement of 18 of the 36 elements which the instrument is capable of measuring. The spectural intensities of these elements are measured by photomultiplier tubes positioned behind exit slits at selected wavelengths.

The output voltage of each tube is proportional to the amount of the element contained in the sample being analyzed. The voltage is interpolated by an electronic glow tube counting system into digital values, which can be handled by the punching mechanism of the IBM system and automatically processed.

Circle No. 241 on Subscriber Service Card.



Read/Write Amplifiers Provide Versatility

Decisional Control Associates' all-transistor read/write amplifiers are claimed to provide the system designer with a complete set of building blocks for digital magnetic tape applications. The circuits are easily incorporated into any type of digital system.

Voltage levels are compatible with either transistor or vacuum-tube systems of logic. The write amplifier uses logical combinations of two input voltages to provide both return-to-zero (RZ) and non-return-to-zero (NRZ) modes of recording.

Pulse response at the two inputs is matched to assure uniform reproduction regardless of tape saturation direction or mode of recording. The basis read circuit is a linear amplifier with a voltage gain of approximately 2500.

Liberal feedback is used to preserve pulse waveform and the frequency pass band is carefully shaped to provide maximum noise rejection. A variety of transitional output circuits is available to supplement the basic read amplifier.

Modular design adapts the new circuits to use in systems of any number of channels. Each amplifier is packaged on an etched circuit plug-in card 3¼ inches by 5½ inches. A typical read/write system for eight channels, consisting of write amplifiers, read amplifiers and transitional output circuits, is contained in a single module occupying 3½ inches of panel space.

Transistors as active elements and operating margins consistent with good digital practice are claimed to result in circuits of outstanding reliability, even at high digit transfer rates.

Circle No. 237 on Subscriber Service Card.

Thirteen Ultrasonic Systems Introduced

High capacity, production-size ultrasonic cleaners, metal-finishing and chemical process machines have been introduced by the Narda Ultrasonics Corp.

The series 600 line comprises

thirteen different ultrasonic systems made up of various combinations of the SonBlaster generator and SonBlaster Ultrasonic Transducer Models NT-601 to NT-609.

The stainless steel transducerized tanks in this series range from ½ gallon to one gallon capacity with single or double tank compartments. Some feature inlet and outlet taps for hook-up with external recirculating systems; others feature self-contained recirculating pumps, filters and temperature controls.

Submersible models NT-604 and NT-605 are hermetically sealed in leakproof heliarc-welded stainless steel cases for use in installed solvent degreasing tanks, process tanks, metal-finishing, metal washing, and heavy-duty cleaning tanks of varying sizes or volumes.

Circle No. 230 on Subscriber Service Card.

AC Summing Amplifier Weighs 12 Ounces

An ac input-output summing amplifier designed for 400-cycle operation has been made available by Waldorf Instrument Co. Weighing only 12 ounces, and measuring approximately 2½" x 1½" x 2½", the unit has an all-transistorized construction offering low power consumption (50 ma drain at 45 v) and high resistance to shock and vibration.

The Summing Amplifier, W1806, may be specified with 7 or 9 pin-connectors or for connection in printed circuits. With a phase shift of less than 1° 20 cps to 1 kc, the unit has a signal frequency of 20 cps to 2 kc (within 1 db at 250 mw output), an input impedance of 3000 ohms and a 10 ohm output impedance.

Circle No. 229 on Subscriber Service Card.

Temperature Transducer Has 0.1°F Accuracy

A sensitive, highly accurate temperature transducer with fast response is being produced by Astra Technical Instrument Corp. The instrument is designed for measuring static and flow temperatures of liquid gases used in rocket motors.

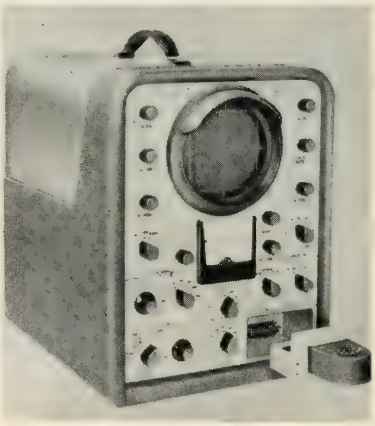
An exposed element in the unit provides a response as fast as 10 milliseconds. Using an amplifier supplied by the manufacturer, a response of one millisecond is possible. Accuracy is better than 0.1°F., depending on the ability of the readout equipment, and resolution of 0.1°F. is obtainable. Using the matching amplifier, an output of ±5vdc per 100°F. can be provided, with a maximum output of ±20 vdc available.

Maximum operating current: 5 milliamperes. Operating range:–450°F. to 2000°F. in eight increments, with +3500°F. available as special.

A probe-type instrument, it measures temperatures of air, water, ethyl alcohol, liquid nitrogen, liquid oxygen, gaseous nitrogen, lubricating and hydraulic oil, and other fluids. Unit withstands acceleration to ±25 g at 0 to 200 cps.

Circle No. 225 on Subscriber Service Card.

Rate Analyzer Offers Solution to Test Problems



Schmeling Electronics has in production their Model 140 Universal Relay Analyzer. This test instrument provides fast accurate testing of relays under actual contact loading, including dry circuit switching, according to the company.

Model 140 checks every phase of relay operation as follows: precise check of pull-in and drop-out voltage, exact measurement of contact make and break time, accurate evaluation of contact bounce, overlap time on make-before-break and break-before-make contacts, and contact resistance measurement with simultaneous observation of all relay contacts.

A cycling circuit permits automatic cycling of the relay at a rate selected by the operator. Adapters to accommodate various relay types may be plugged into the front panel. These are designed so they may contain switches for special measurement, such as analyzing relays with 8 form "C" contacts.

Accessories supplied include a universal adapter with wire leads and miniature alligator clips, connector for external contact power supply and contact loads and instruction manual.

General specifications includes—Input: 117 volts, 60 cps, 180 watts. Size: width 13", height 16¾", depth 18½".

Circle No. 233 on Subscriber Service Card.

Timer Measures Billionth of a Second

A timing device that measures time intervals as short as a billionth of a second has been developed by Eldorado Electronics Co. The new instrument, known as "Nanosec," extends the art of time measurement three orders of magnitude from the millionth of a second range possible with present equipment. A billionth of a second (or nanosecond in the metric system of measurement) is the time it takes light to travel approximately three feet.

Intended originally as a nuclear research tool, "Nanosec" can be used in the fields of radar, computer and solid state physics where requirements have outstripped the ability of conventional instruments. "Nanosec" applications include neutron time-of-flight measurement, determining the half-life of short-lived radioisotopes, fast-coincidence circuit studies, delay line calibration in radar circuits, and transient time studies.

"Nanosec" consists of two basic elements—a time-to-amplitude converter and a 20 channel amplitude analyzer. In use, a time interval under measure is converted to a pulse of proportional height. The pulse height is measured by the amplitude analyzer and registered in one of the analyzer channels. Each channel corresponds to a known time interval. By noting which channel registers, the operator can determine the time interval.

Circle No. 238 on Subscriber Service Card.

Phase-Lock Discriminator Features Modular Design

Hallamore Electronics Co. has developed a phase-lock discriminator in building-block form. The unit, HEC-0162, eliminates suppression of signals by noise, non-linearities introduced by filtering, and thresholding at low signal-to-noise levels.

The company says operation in missile data reduction centers has demonstrated the capability of the discriminator to produce reliable data at

S/N ratios, which renders pulse-counting type discriminators inoperative.

The HEC-0162, one in a series of building-block components, is said to simplify operational procedures, afford economy in mounting space, eliminate system errors and provide a near-optimum information handling efficiency.

Standard production models include all IRIG channels, including the optional wide band (15% deviation) channels. Non-standard discriminators are fabricated according to customer requirements.

Circle No. 248 on Subscriber Service Card.

Electromagnetic Transducer Accurate to 1 Sec. of Arc

Sterling Precision Corp. is producing a new T833 transducer—a differential transformer type pickoff consisting of an E-Core stator and one or more separate companion rotors. The transducer, or "E Coil," is accurate to 1 sec. of arc and is used in position pickoff in servo rate or optical systems.

Although primarily designed as a positional trip on Sterling Test Turntables, the unit may be adapted for use as an electromechanical transducer for precise measurement of both linear and angular displacements.

The dimensions of the Sterling transducer in potted core are 1½" x ⅝" x ½" high, while in potted housing the dimensions are 2" x 1½" x ¾". The rotor face is .250" diameter round or .250" square. Excitation: 5 to 100 ma/300 cycles to 2 KC. Sensitivity is measured at 0.1 ma per .001" per ma excitation at 400 cycles.

Circle No. 251 on Subscriber Service Card.

Improved Data System Now Available

Beckman Systems Division is producing a new data processing system, the Model 123. The system has been designed to meet the needs for a high quality data handling unit, retaining the concepts of reliability and accuracy in processing.

The Model 123 is equipped to scan 100 points at the rate of one per second. The system provides 25 combinations of scaling and zero off-set, high or low alarm limits and square root extraction for flow measurement computation.

It utilizes the same components as the Beckman Model 112 Data Processing Computer, using transistors throughout, sealed stepping switches, and all solid state components. Programming is simplified by use of the Beckman Systems pinboard. Cost has been kept to a minimum in the Model 123 by manufacturing the system as a standard item rather than a custom item.

Circle No. 249 on Subscriber Service Card.

Centrifuge Slip Ring Used For High-Voltage

A new centrifuge slip ring designed for use with exceedingly high-voltage has been produced by Slip Ring Company of America, Los Angeles.

It has three high-voltage circuits capable of 10 kv dc, continuous and was tested at 20,000 volts hi-pot. Instrumentation circuits are unaffected by adjacent high-voltage circuits. Minimum noise is accomplished by the use of precious metals.

Dual brushes, riding on each ring and tuned to different resonant frequencies, provide uninterrupted circuits. The assembly is rated at 350°F continuous operation. All 15 slip rings and shielded wires are high-pressure molded into one assembly.

Circle No. 245 on Subscriber Service Card.

Strip Chart Recorder Eliminates Inking Need

Mandrel Industrial Instruments has introduced the ER-20 direct-writing strip chart recorder for electrical data from dc to 100 cps. Coupled amplifiers give a sensitivity of 2 mv/mm.

Stylus deflection on each channel is 40 mm, with an accuracy of 2%. Electro-sensitive paper eliminates the need for any inking system. Easy paper loading and an electrically-controlled chart drive make operation simple.

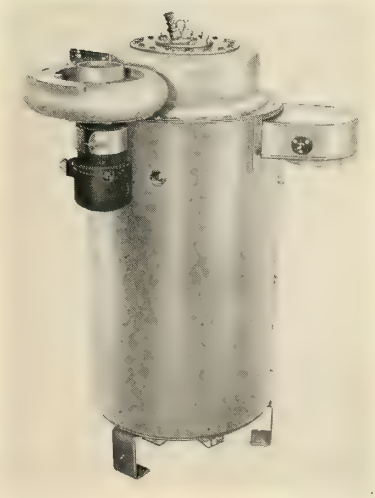
Circle No. 246 on Subscriber Service Card.

Mechanical and Materials

Million BTU/hr Heater For Ground Support

A liquid heater, with output variable from 0 to 1 million BTU/hr, has been designed to be extremely compact for missile ground support applications. The unit, manufactured by Janitrol Aircraft Division, automatically maintains liquid at any desired temperature. It operates as a complete heating system for such applications as missile-fuel heating during transfer, vaporizing, maintaining liquid temperature during storage, providing personnel comfort heat in building and support vehicles.

The heater stands 46½" high, is 18¼" in diameter, and complete with controls weighs about 257 pounds. Radio noise shielding meets the requirements of MIL-1-11683 and it will operate in extreme environments to −65°F. Designed for multi-fuel use, the liquid heater can be adjusted to burn either fuel, gasoline, or JP-4.



In use, the heaters may be operated individually or may be combined in modular units to meet virtually any requirement for large amounts of controlled heat. The heater operates at 75% efficiency. Units are designed for easy access to all parts for servicing and maintenance.

Automatic holding of a predetermined temperature is accomplished by cycling the heater. Controls operate on 24 volts dc. In addition to the heater itself, a complete unit includes a fuel train bracket which incorporates a filter, a positive displacement fuel pump, a pressure regulating fuel valve, a solenoid valve, and a fuel pressure gage.

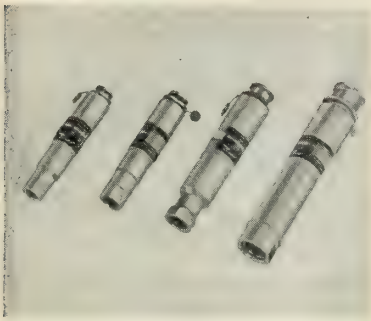
In addition, a 4½"w x 3½"d x 6½" control box contains a circuit breaker, ignition vibrator point selector switch, and a safety switch which cuts off the unit in case of failure in ignition, fuel flow, or air flow. The safety cut-off switch also lights a trouble warning lamp.

Standard models are furnished with a cycling switch set to cut out at

195° ± 50°F. Cut-in setting is 180° ± 5°F. A high limit switch is set to cut out at 210°±5°F., and automatically restarts the heater when liquid temperature drops 10 to 20 degrees lower than the cut-out temperature.

Circle No. 253 on Subscriber Service Card.

Relief Valve Features Light Weight, Compactness



Bendix Aviation Corp. has developed a new line of hydraulic inline unbalanced relief valves designed for light weight, compactness, simplicity and maximum performance.

The valves conform to MS28887 Type II envelop, and are designed to meet or exceed MIL-V-5523B and the proposed "C" revision, Type II specifications (reverse flow excepted).

A special compensating design feature allows use of extended flow rates. As high as 4.5 times MIL-V-5523B rated flow has been accomplished without exceeding the allowable pressure differential.

All valves have been fully qualified from −65°F to +275°F. Adjustments for maximum pressure settings range from 500 to 3850 psi, and can be made available as high as 4850 psi. Readily available from stock are ¼", ⅜" and ½" tube sizes.

Circle No. 227 on Subscriber Service Card.

Heavy Duty Cylinders For Automated Equipment

A new line of heavy-duty air and hydraulic cylinders, especially designed for use on automated equipment, is being produced by the S-P Manufacturing Corp.

The general purposed heavy-duty cylinders have pressure ratings of 200 psi (air) and 1000 psi (hydraulic). They are offered in nine sizes and in five mounting styles: flange (blind end), flange (rod end), clevis, adjustable trunnion and foot. Sizes range from 1½" to 8" bores, with strokes to customer's specification.

All models are available non-cushioned, cushioned blind-end, cushioned rod or cushioned both ends. Mounting dimensions of cushioned and non-cushioned cylinders are identical. Cushion check and cushion adjustment may be interchanged without further cylinder modification.

According to the manufacturer, high performance and long life, with minimum maintenance, are assured by the design and construction features of the cylinders. Honed seamless steel barrels, steel and plates; and heat treated low carbon, low alloy steel piston rods are structural features of the units.

A radius at the end of the rod thread prevents stress concentration and facilitates installation of seal cartridge. Large ports provide fast cylinder operation, and alternate port positions are available. All ferrous parts are rustproofed for resistance to corrosion.

Piston and cartridge-retained rod seals are designed for operation at temperatures ranging from −20° to 150°F. Special seals for higher or lower temperatures and piston ring construction, for hydraulic cylinders only, are optional.

Circle No. 235 on Subscriber Service Card.

Regulator Prevents Electronic Destruction

A specially developed air pressure regulator, used to prevent self-destruction of electronic guidance equipment on guided missiles, is now being produced by the Garrett Corp.'s AiResearch Manufacturing Div.

The regulator maintains approximate sea level pressure in an electronics compartment. Without this environmental control, the equipment would be subjected to destructive electrical arcing at the low pressures of high altitude. The unit weighs just ¾ lb., measures 3" high, with a housing diameter of 2¼" and an attachment flange diameter of 4".

Essentially, the unit is an outflow valve operated by a spring and bellows arrangement. The interior of the bellows is evacuated to approximately zero pressure. As the unit is carried to higher altitudes, faster flow of gas from the compartment to the atmosphere results in lower compartment pressure on the bellows. This allows the bellows to expand with the assistance of the spring.

The resulting action positions the valve to lessen the opening that permits flow to the atmosphere. In this manner, the gaseous environment of the chamber is kept in circulation at a constant pressure position.

A unique feature of the regulator is the mechanical connection between the bellows and valve, rather than a pneumatic connection as used in other units.

Circle No. 240 on Subscriber Service Card.

Dexterous Missile Gear Handles One Hundred Tons

Industrial Products Engineering Co. has developed a new type of missile-handling equipment to accommodate weights ranging from one to one hundred tons. The equipment, intended for use in plants engaged in missile manufacture and assembly, accommodates cylindrical objects by use of a circular "shoe." It picks up missiles in a horizontal position and rotates them to a vertical position for additional work or assembly.

The electrically-operated unit travels on an overhead track to deliver missiles to various parts of an assembly line. Using a uniquely designed type of closure, the shoe (together with a support shoe) can pick up and manipulate missiles in various positions without the need for support structures or external rigging.

Circle No. 257 on Subscriber Service Card.

Temperature Probe For 3200°R at Mach 5



Aero Research Instrument Co. Inc. has developed a total temperature probe for operation up to 3200°R at Mach 5.0.

It is made through the use of a

new metal process that promises to lend itself for other high temperature measurement applications, i. e., ram jet and afterburner exhaust.

The probe uses a platinum 13% rhodium-platinum thermocouple. Actual wind tunnel data shows a recovery factor close to unity at 70,000 feet. Missile use has been at altitudes of at least 2 x 10 feet. and has survived re-entry.

Circle No. 242 on Subscriber Service Card.

GE Markets Series of New Silicone Compounds

General Electric has added three new general purpose silicone rubber compounds to the standard product line of the Silicone Products Department. Designated SE-452, SE-472 and SE-482, these meet or exceed MIL-R-5847C Class II specifications.

Tensile Strengths of 800 to 1,400 pounds per square inch, tear strengths of 80 to 200 pounds per inch, and elongations of 250 to 550% are obtainable with all three compounds. Properly cured parts fabricated from these compounds exceed the appropriate tensile strength requirements of MIL-R-5847C by 23 to 54%.

SE-482 is said to offer greater tensile strength than any other commercially available 80 durometer silicone rubber, and is best suited for fabrication by molding and calendering. It may be blended with the softer SE-452 to obtain compounds of intermediate hardness.

SE-472, a 70 durometer hardness stock, and SE-452, a 50 durometer stock, have excellent processing characteristics, according to GE, and are especially suited for fabrication by extrusion. SE-472, which meets the standards of AMS3357 as well as those of MIL-R-5847C, is also well suited for calendering.

All three rubbers may be used in extended service over the temperature range of –75°F to 500°F. Although manfactured as white compounds, they may be tinted during fabrication to obtain a wide variety of colors. SE-452, SE-472, and SE-482 are available in commercial quantities.

Because of their good physical characteristics, which include very low water absorption and resistance to compression set, these general-purpose compounds are suggested for a wide variety of sealing, gasketing and mechanical applications in various phases of missile and aircraft manufacture.

Silicone rubber room-temperature-vulcanizing (RTV) compounds, capable of being poured or spread in place, have been developed by General Electric. The compounds can fulfill a wide variety of caulking, sealing, patching, encapsulating, and potting application on missiles and on the various components used.

The RTV compounds do not require the heat cure ordinarily used for silicone rubber, but GE says they possess much of the long term heat resistance and low temperature flexibility unique to silicone rubber. In addition, they exhibit the silicone's outstanding resistance to ozone, weathering and aging.

Because they may be poured or spread in place, compounds 80774 and 81813 are readily used in sealing, filling irregularly shaped voids, and covering components for which molded or extruded parts are difficult or impossible to fabricate. Bonding of these compounds to aluminum, copper, stainless steel and other metals; and to other materials such as glass, ceramics and plastics is easily done. Such bonds are actually stronger than the elastomer itself at temperatures as high as 625°F.

Circle No. 228 on Subscriber Service Card.

Heat Exchanger Cools Guidance System Tubes

In ambient temperatures from —65° to +135°F; from sea level to 10,000 ft., mounted unsheltered on an off-the-highway portable vehicle, this unit, developed by Lear, Inc., is designed for cooling a klystron tube associated with the ground guidance systems of missiles.

Under adverse conditions, while maintaining a controlled liquid outlet temperature of 170°F plus or minus 5°F, the unit has a nominal heat dissipation rate of 6000 watts.

Both electric motors are continuous duty, 208 volt, 3 phase, 400 cycle. The pump motor is 0.5 hp at 2600 rpm, and the fan motor is 1.25 hp at 11,000 rpm. At 2,600 rpm the liquid flow rate is 2.6 gpm with a 170 psi cooler differential pressure.

Safety features include a pump relief valve to by-pass full flow at 245 psi gage cooler discharge pressure, and a safety heater thermostat set to open at 300°F. For liquid preheat prior to energizing the electronic gear, the unit includes a thermal by-pass system which prevents liquid flow through the external system below 100°F.

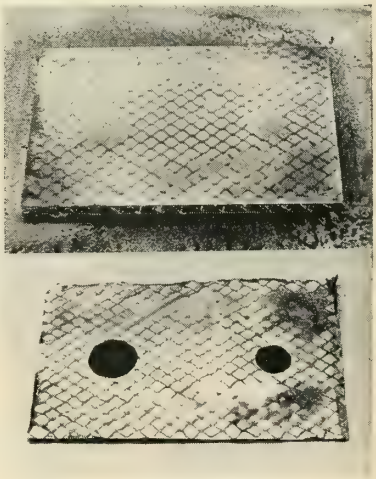
Circle No. 250 on Subscriber Service Card.

Kit Locates Lack of Bond In Honeycomb Structures

A method for checking the bond in honeycomb structures is available in kit form. The Bondcheck BC-1 inspection kit is used on metallic honeycomb, soldered, welded or brazed-to-the-skin surfaces.

The test procedure includes cleaning the part surface and spraying on a specially formulated red fluid that is repelled by heat and tends to flow to the coolest area on a metal surface. A controlled heat is then applied from a high intensity infrared lamp.

This heat is conducted from the inspected surface to the honeycomb core wherever good bond exists between the core and surface. Since the visible fluid flows to the coolest areas, it accumulates at every point of good bond, reproducing an exact pattern on the bonded area. Areas of defective bond are visible as gaps in this pattern.



The upper photo shows Bondcheck indications of honeycomb patterns. Void areas reveal lack of bond between skin surface and honeycomb core.

In the lower photo, removal of outer skin shows actual defective core and verifies the accuracy of Bondcheck's pattern.

Deformed core materials are also readily apparent, with the inner core pattern visible in the outer surface pattern. The test takes only a few seconds per area tested. Any complex shape can be tested, and automatic testing is practical on simple shapes.

Circle No. 247 on Subscriber Service Card.



NAVTAC: "Pipeline" to a happy landing

The uniqueness of the new NAVTAC en route navigation and instrument landing system by Stromberg-Carlson is in its *combination* of functional modules.

The NAVTAC equipment is an assembly designed to provide high-performance aircraft with the TACAN navigational aid, plus marker beacon receiver, glide slope and runway localizer for instrument landing situations.

The entire system is packaged in a compact unit only 5″ high, 10½″ wide, 22″ deep, and weighing only 47.5 lbs. Individual modules can be separated up to distances of several feet without any adverse effect on performance.

The equipment is designed to meet the rigorous environment of the high-performance aircraft of today and tomorrow. Its operating ambient temperature range is −60 to +125 degrees C. at altitudes up to 70,000 feet. Widespread use of semiconductors in the ILS receivers and TACAN circuitry means high reliability, small size and low power consumption.

Included in the design is the capability of performing complete preflight confidence tests with the use of a small auxiliary test set.

Complete technical details on the NAVTAC system are available on request.

There is nothing finer than a Stromberg-Carlson®

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A DIVISION OF GENERAL DYNAMICS CORPORATION

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Electronic and communication products for home, industry and defense

Circle No. 113 on Subscriber Service Card.

Selling Subsystems

by Seabrook Hull

Like other phases of the rocket, missile and space flight business, selling subsystems and major components is primarily a marketing and sales problem.

Analyze your market; figure out where you fit in; where you want to be ten years hence; and then get out and do some old-fashioned hard selling.

If personal, inspirational selling is no longer necessary in consumer goods because of a Madison-Avenue-kind of mechanization, that's no indication that missile business can be had the same way. With missiles, competition is reminiscent of the early depression thirties—just as keen and just as cut-throat.

If you're selling a subsystem, you make your major parts of a missile system. This doesn't mean that you must have as big a technical staff as the prime systems contractor. But it does mean that you must understand his problems thoroughly, and you must have a technical staff sufficient to research and develop your portion of the job.

• **How to sell**—You cans ell subsystems either as a prime or a subcontractor, though more often than not it's the latter. Generally, you're a prime in the production stage; a sub in Research and Development. The Army used to place all its subsystems contracts as prime contract work, retaining overall systems responsibility within an Army Arsenal. However, the Army, Navy and Air Force now almost always places the initial research and development prime systems contract with a commercial prime contractor. Thus, to get subsystems business you should go to the company with the prime contract.

This means knowing who is going to get the contract in advance. You've got to be on the road ahead of time—talking, listening, prying, calculating.

It boils down to this: The first step in selling is to know your market. The way you get to know this market is to get around.

It pays to make calls. Once you've settled on a project in which you want to be a subsystem contractor, and you think you know who's going to be placing these subsystem contracts, go visit the lucky company.

Walk in armed with as much knowledge as possible of the whole project, and an ever better knowledge of the part you want to play. Offer suggestions—backed by engineering knowledge—of how to do the job better: how to put reliability and low cost into guidance, how to make all ground support mobile, how to get 40 more points of specific impulse out of a real simple, inexpensive solid propellent engine.

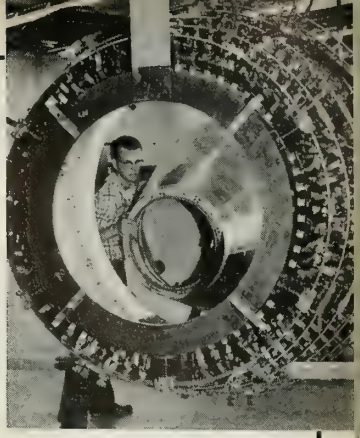
So, you get in on the ground floor as a major subsystems contractor at the R&D level. And, you think you're set. Well . . . maybe.

• **Pitfalls**—Loud and pitiful have been the howls in Washington from companies who held the initial subsystem contract for a missile and who carried through the research, development and prototype stages, only to lose the production contract.

In part, their howls are justified. A contractor might have taken a subsystems job on a cost-plus-fixed-fee basis, only to find that change-orders had tripled the cost, while the fixed fee remained fixed. Thus, planned percentage on gross was cut to one third.

Government, however, takes a different view, charges that too many companies with initial R&D contracts try to make a killing on the first production contract, and thus lose out to lower bidders. Best advice: Don't count chickens until you've got a good idea of what your competition is willing to do.

• **Group bidding**—Subsystems contracting is a highly responsible business. It is every bit as important as prime systems work. This is evidenced by the growing acceptance of the group method of bidding.



Chrysler Corp.

Here, the subsystems contractor becomes a responsible part of the prime contracting team. This is where a group of companies with complementary capabilities bid on complete systems as though they were a single integrated company team.

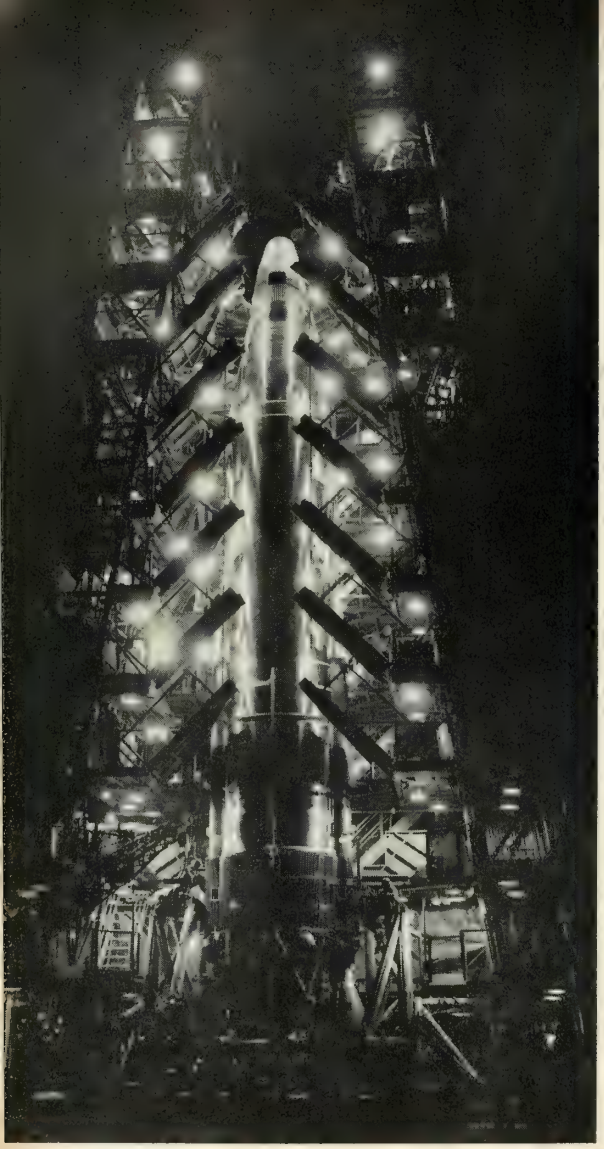
Navy in particular favors this approach by industry, especially with missiles that are going into production. However, there are a few things any potential group should keep in mind. First are "responsibility" requirements.

Any contracting office is properly concerned with whether the individual companies in the group are legally compelled to carry through, once committed. The fear is that if one of the companies should decide to drop out part way through a program, the whole project might be endangered.

Two other requirements for the group are that it have some kind of clearance, perhaps from the Justice Department, indicating that it is not in violation of any anti-trust laws; and that member companies will abide by decisions of that part of the group vested with systems responsibility.

With these assurances and with the right balance of technical, scientific and industrial resources, a subsystems contractor can move into the prime systems field. The next step after successfully participating in a group project could well be to bid for and win a prime systems award.

Meanwhile, remember: Subsystems are a lot more competitive than prime systems. But the prize is worth the run, since those who establish their reputation now will have a head start in the coming age of production missiles and space flight projects.



Atlas Testing

Sub-systems on trial in captive firing stand

STATIC FIRINGS of the *Atlas* ICBM at the Sycamore Canyon Captive Missile test facility of Convair-Astronautics and at Edwards Rocket Base are credited with the relative success of the *Atlas,* according to Col. Otto Glasser, assistant deputy commander for weapons systems, Air Force Ballistic Missile Division.

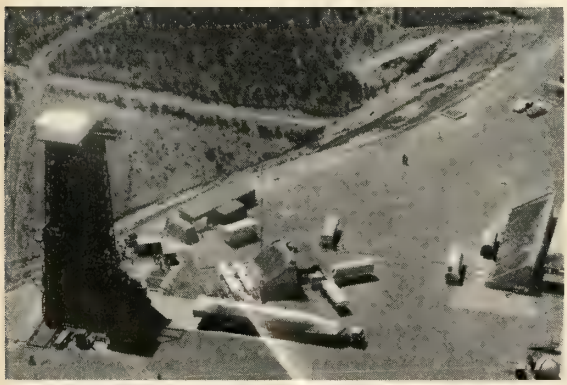
"Without these facilities we wouldn't have been able to get *Atlas* off the ground at Patrick AFB," he added, "and the program probably would have been cancelled for lack of success."

The Sycamore Canyon static firings began on "X-minus-1," the wing-shift of the day before the test was scheduled. On the morning of the test day, the test crew started a four-hour cutdown of about 4,000 items. In actual military operations, minus all the development and test equipment, an *Atlas* can be fired in a matter of minutes.

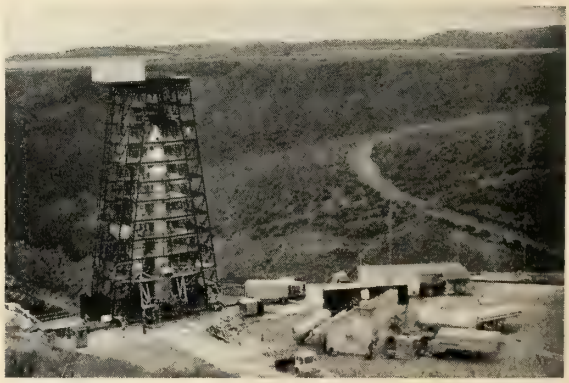
Although the launch procedures, test equipment and related ground equipment have been checked out during each static firing, additional firings will be made in a few weeks at Cooke AFB. Construction of the new launching test site is moving rapidly.

When the Cooke pads are completed, they will serve two purposes: the facilities will be to train *Atlas* crews, and carry out actual launching of missiles into the new Pacific Missile test range. In addition, the Cooke tests will enable the Air Force and Convair-Astronautics to polish up the design integration and guide the configuration of future sites, such as those to be built at Warren AFB, Cheyenne, Wyoming.

When the *Atlas* goes into production, it will cost about $1.7-million per unit, but present costs are in the neighborhood of $2-million.



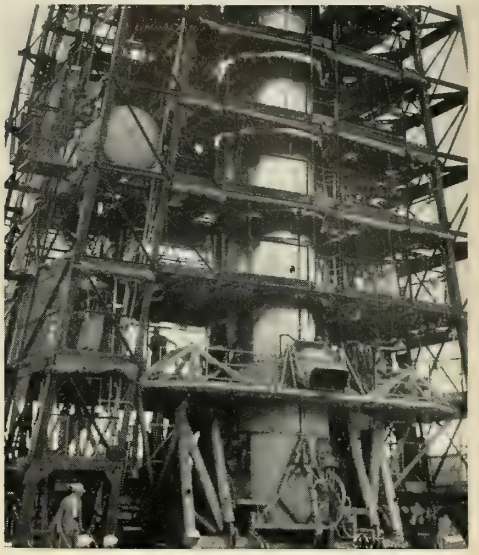
A SHROUDED *Atlas* missile arrives at Convair's Sycamore Canyon facility for captive testing. Part of the two-level reinforced concrete blockhouse, which serves as a test control station, can be seen at upper right. Liquid oxygen propellant for the missile is stored in a tank behind bunker.



FINAL PREPARATIONS are made for a "hot" run. The two small tanks to the left of the bunker (right foreground) are used during pressurization tests. Liquid nitrogen and helium trailers are stationed to the right of the bunker. Other equipment sheds and vehicles are grouped near the stand.

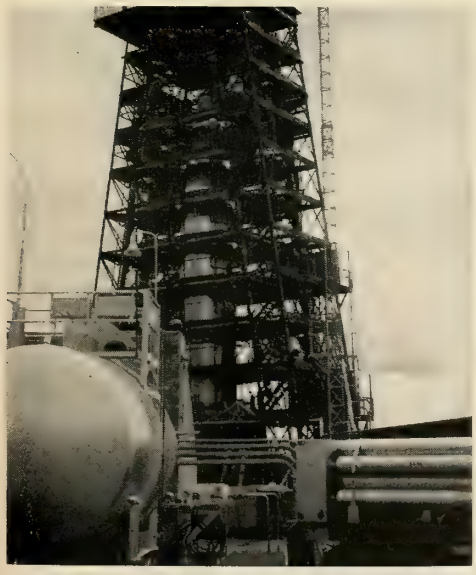


RESTING on its handling trailer, an *Atlas* is raised into static test stand. The trailer transports the missile from the San Diego plant of Convair-Astronautics to Sycamore Canyon and Cape Canaveral.



IN A CLOSE-UP view, the flame deflector (for testing only) of one of the missile's two vernier engines is plainly visible. Thrust measuring devices are located at the base of the 100-foot-high service tower.

HUGE STEAM CLOUD dwarfs the tower during captive testing. Steam is generated as exhaust strikes a water-cooled deflector. Water pours over the deflector at 30,000 gallons per minute.



PROPELLANT TRANSFER facilities pump LOX and RP-1 fuel at rates up to 1,000 gallons per minute. 30,000 gallons of LOX and 16,000 gallons of fuel can be stored at the testing facility.



Can this experience in unique cooling applications help solve a problem for you?

Custom designed cooling is our business at Ellis and Watts. For example, we have recently engineered and built highly specialized equipment for the following applications:

- Liquid coolers for electronic components (bulletin 94)
- Cooling Klystrons with air to liquid heat exchangers (bulletin 95)
- Special units to cool airborne electronic gear (bulletin 99)
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Our Confusing Security Program

Q. Congressman, what are the ultimate goals of your Committee?
A. I think we have to create an atmosphere of greater freedom for the men employed on science and defense projects. There should be honest-to-God cooperation and coordination between the military departments, and a civilian agency to direct and supervise the type of research we will undertake, so that the tendency of the military departments to hold on to every bit of knowledge they develop is brought to an end. I think we're still spending far more than necessary in duplicating research. This is true of missiles or any other field where we have to make advances and breakthroughs in scientific knowledge. This is what our Committee is looking into.

Q. Can you give us any idea of what action might be taken to rationalize the security program? Can you do this legislatively?
A. It can be done legislatively. It will take much more time; it will be much more difficult. It should be done by administrative action or through a coordinated program recommended to the Congress by the executive. There is no substitute for an informed and a fully responsible executive in this or any other field.

Q. You've got a Democratic Congress and a Republican administration—which always leads to a bit of friction. Do you see any signs that the executive, i.e. the administration, is going to do this on its own?
A. Signs are so faint as to be almost non-existent.

Q. Which throws it back in your lap again?
A. It throws it back in our lap. We're handicapped because we haven't immediate access to the information we need to make a sound decision.

Q. Has there been any proposal made for instituting—passing a law—which would specifically define the rights of the public and Congress in limiting classification?
A. No. because that's much more difficult than it sounds. In fashioning such a law, or trying to spell out precisely what the public can know, legislation will not be easy. In the first place, I think the rights of Congress are inherent in the Constitution and all Congress needs to do is move forward in asserting its rights, demanding that they be recognized by the executive.

Q. Aside from taking such forward action have you come to face with a dilemma? Have you talked with McElroy on this subject?
A. No, I haven't talked with McElroy. I might add that we tried to work cooperatively with the office of the Secretary for the first two and a half years of the Committee under Secretary Wilson. We made little progress. We haven't had occasion to contact Secretary McElroy. That may be a matter for action in the near future.

Q. Do you have a feeling that you will get more cooperation from McElroy's office than you did from Wilson's?
A. I have stopped trying to determine the cooperation we might get. I was most hopeful that we would get more cooperation—honest cooperation—from the office of the Assistant Secretary, Mr. Snyder, than we had from his predecessor, Robert T. Ross. I can't honestly say that we have had more cooperation. I do feel that there has been a more skillful policy of management in Pentagon matters than under Ross. If we're going to be faced only with a more skillful handling of the problem but the same final result under Mr. McElroy as was true under Mr. Wilson, then we will have made little progress.

Q. Do you feel that more cooperation from the Pentagon is needed for your



". . . we must create an atmosphere of greater freedom . . ."





". . . I was quite hopeful that we would get more cooperation . . ."



Committee to do a proper job?
A. More cooperation is needed not only for my Committee to do a proper job, but the military itself will profit. When I say that, I mean that if the military would cut through this maze, of confusion and over-classification, it would be of tremendous importance to them in doing a better job.

Q. **How can we change this attitude? Can McElroy himself change it simply by a directive, or do we need a whole new re-education program?**
A. I think one of the ways we can change the attitude would be to again revise the rules and regulations regarding information from the Pentagon. They were revised following the reports of the Coolidge Committee and of the Commission headed by Lloyd Wright. The revisions in my judgment would be a tightening up of news rather than a freeing of it. When I use the term news, I use it in the broad sense—in effect—all information that might be of interest to anyone. I think the one thing we overlook is that we are not getting security as a result of these programs. We're only slowing down our progress in basic scientific development and in the application of scientific principles to weapons systems. I think the missile is certainly an illustration of that point. Another failure of these regulations is in attracting and holding the type of scientific manpower we desperately need in our research programs. We're discouraging our universities from taking contracts requiring classification. Universities feel that many of the classifications imposed are ridiculous; it is frustrating to their people and they just don't want anything to do with it.

Q. **Could one of the problem points of classification be that we don't inform our people of information our intelligence organizations receive about the Russians?**
A. Yes, it is. I don't think it's valid that the Russian MIG we purchased is still tightly classified. There are many things that are classified that are common knowledge to the Russian government. And sometimes I wonder what is the real objective of our classification system: to keep information from the American public, or to keep information from a potential enemy?

Q. **Is it to protect those in power?**
A. It's to avoid embarrassment and the need for explanation in many instances.

Q. **Have you asked any of your witnesses how they justify this withholding of Russian information?**
A. Oh, yes, we always get an answer. "If you let the Russians know what you're interested in, they will be in a better position to gauge your present rate of progress." I don't buy this, but it's offered to us time and time again. I think we could find out a great deal about the Russians if our government had a little more interest in translating and reading the information which the Russians make available to us.

Q. **Is your Committee concerned with the lack of translations?**
A. Oh, yes, we are looking into it.

Q. **What have you found, so far?**
A. You recall that we discovered the Rand translation of the Russian radio publication last fall had been completed considerably in advance of the *Sputnik* launching. Had our government read this information and informed the American people, we probably would not have been surprised when the Russians launched their first satellite. The publication gave the modulations of the transmission, what they would be measuring and what the measurements were. A week's time elapsed while our government was trying to determine the frequencies for the purpose of tracking the satellite. Yet this information was clearly published months in advance of the launching.

Q. **Has Congress been able to get a detailed, comprehensive idea of the extent and rate of progress of the Soviet space flight program (to the knowledge of our intelligence data)?**
A. It would be difficult for me to answer that. Until the Armed Services Committee and the Military Sub-committees on appropriations have reported to the House, I have no way of knowing how much information Congress has been able to get from the government. Of course, in this area, I feel that we definitely need a Congressional joint committee to supervise and review the activities of the CIA.

Q. **Do you think the American public has been properly informed as to the potential significance and importance of space flight?**
A. No, I don't.

Q. **Has your Committee been given any assurance, or have you obtained any information of the type of program**

▲

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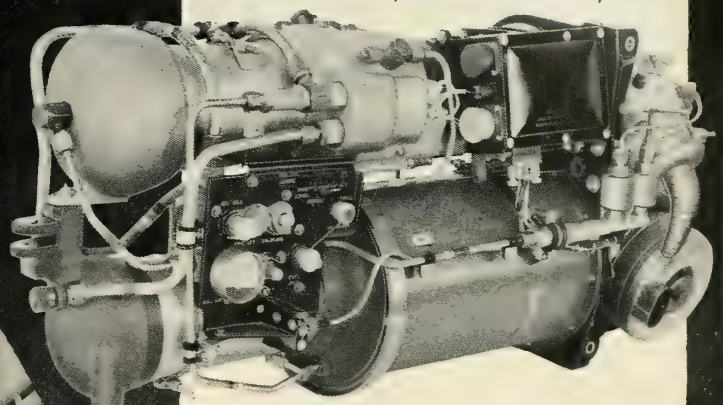
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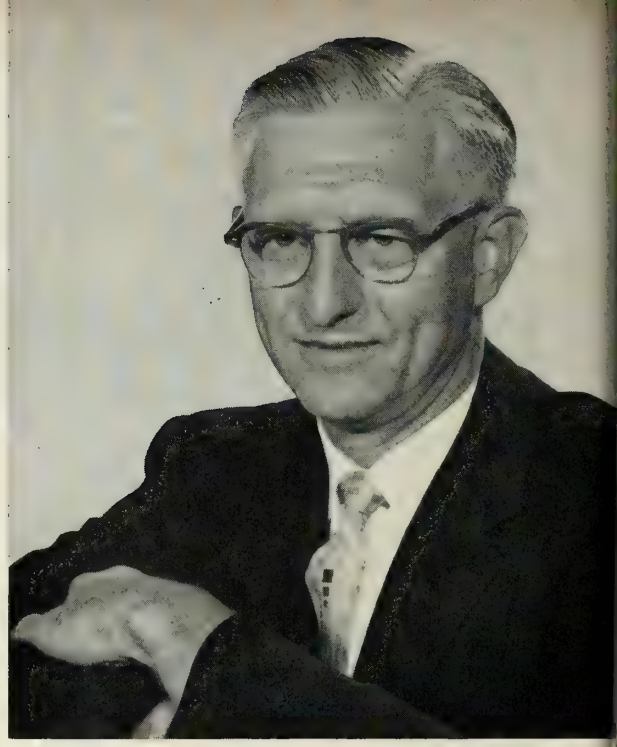
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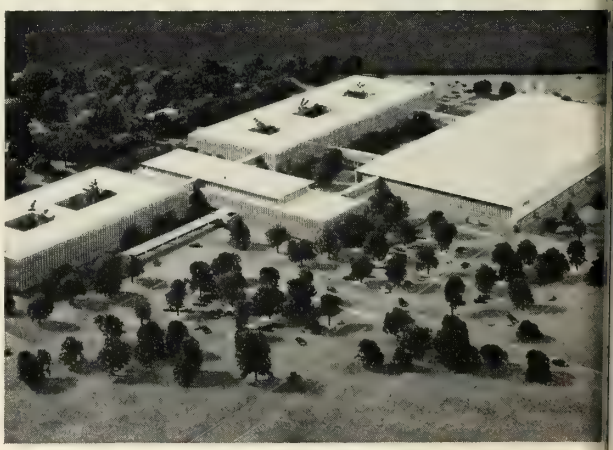
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Robert D. Grange,
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Robert D. Grange



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our Advanced Research Projects Agency will undertake?
A. No, I haven't.

Q. **Concerning scientists—is the exchange of information within the security system a problem?**
A. Oh, I think it's very definitely a problem. Within the security system—even within one department—you may have a number of missile contracts in the Air Force. The information on these projects is not available even to a man who is cleared for that class of information. Again, you have to establish the need to know which is a very difficult thing to do. The fact that you are working on a top secret project for the Air Force does not guarantee that you can have access to all top secret information in that Department, even though the projects may be comparable. Between the services we've encountered the same barrier. The Air Force doesn't recognize an Army clearance. The Army doesn't recognize a Navy clearance. So we clear department by department, project by project and information is available only in the same way. Again, this complete compartmentalization both of manpower and of information is hampering our progress.

Q. **What are we going to do about it?**
A. Keep probing and needling; hoping that we'll be able to change their attitude. One thing that worries me—when the Japanese attacked Pearl Harbor, we had two years or so to get organized and get on our feet. Well, the Japanese made some bad mistakes. If they hadn't we might not have the two years. But we had a long period of time. If—today—anybody decides to push buttons, either literally or figuratively, we've got about 25 minutes.

Q. **In this particular instance, we don't have time to catch up when the chips are down. Do you see any hope? You've demonstrated we can't legislate. You also demonstrated that the executive itself isn't going to do anything about it. What's the "out."**
A. Well, that's a pretty tough question. I've been looking for that answer for two and a half years and I'm not prepared at the moment to say whether I have the solution. We're seeking it, we have ideas, but at the moment they're not in a form where we can legislate. We hope to take a 1789 statute enacted for the purpose of conferring upon the departments and agencies of government necessary authority to keep records—but which has now been tortured into an authority to withhold information—and restate in content the original intent of Congress. This statute gives the departments the custody, use and preservation of their records. They've used it to withhold—so we're merely adding language to the effect that this statute does not grant authority for withholding. We're having quite a bit of trouble. All of the executive departments are opposed to the amendment.

Q. **That will leave them authority for withholding information?**
A. It will leave them in my judgment, all the authority they need. It is specific statutory authority. Remember, this is in the field of nonsecurity information. There's sufficient authority, about 70 statutes, to permit them to withhold anything that is security.

Q. **On what basis can they decide it should be withheld?**
A. Anything can be withheld that is required by the government from business or industry reflecting trade secrets, or statistics of interest to the business or its competition. Of course, income tax can be withheld. The records of the FBI are protected. There's authority for just about anything the executive departments want to do in this field.

Q. **You're going to repeal this act?**
A. We're not going to tamper with the authority to manage records. But we are going to deny the executive the right under that statute to withhold information.

Q. **What effect do you think that might have?**
A. Specific authority will be needed for withholding. And in the process of getting authority, it will have to be justified. Where authority has been given, it will be necessary to specifically cite that authority and relate it to security.

Q. **Your Committee has made big progress on one point—the name of the Moss Committee shakes terror into many people at the Pentagon.**
A. The only criticism we have to that is—the name of the Committee is used, but the need to use the name is very rarely reported to the Committee. We would be able to do a much better job if we could know of the instances of withholding or refusing information encountered by reporters.

Q. **In other words, you invite those**

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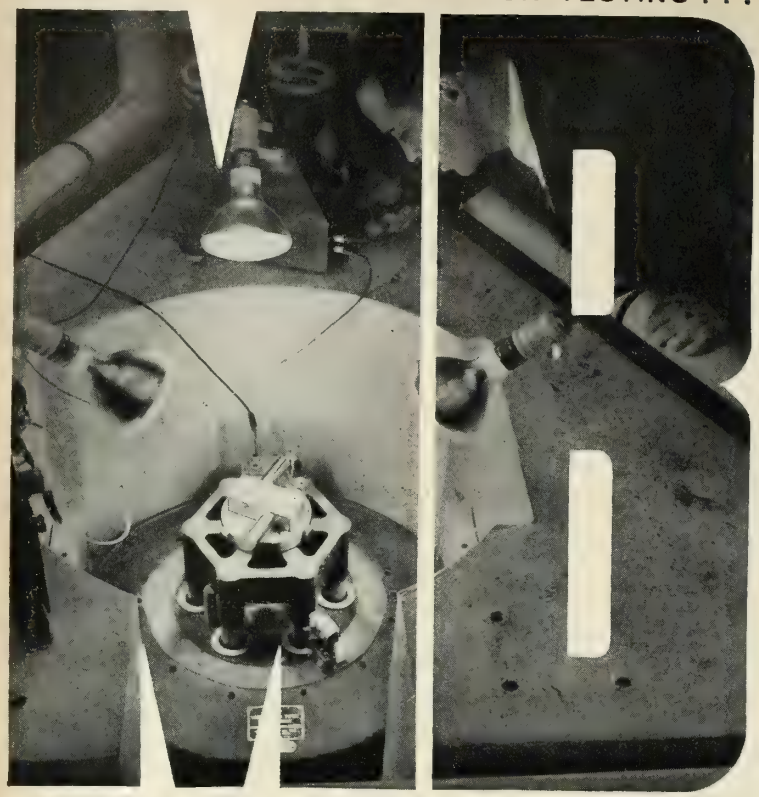
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kinds of reports?
A. Oh, we do—I should say we do! We can only investigate and call these departments which have refused. In every instance where we've caught them, it was as a result of a complaint filed with the Committee, or a tip-off to the Committee.

Q. **I wonder if you have received any complaints on a problem that we're faced with all the time. We hear of a story and think it's a big scoop. When the story is checked with the Department of Defense, Army, Navy or Air Force, we're told "you can't write anything about this, it's classified." They promise to let us know later. In about a week a release is sent out, or someone gives a speech and breaks the story.**
A. We would want to have those instances reported to us as soon as permission is refused.

Q. **Would you say that you study all aspects of the security program? Are you currently concentrating within that field?**
A. We are currently concentrating on scientific information.

Q. **Are you having formal hearings?**
A. We have had some hearings—we will have more hearings.

Q. **Do you anticipate that you will publish your findings?**
A. Oh, yes.

Q. **Better not classify them.**
A. They will be available.

Q. **In your opinion, do you think the preparations for the *Vanguard* firing should have been less publicized?**
A. You're thinking of the December 6th firing? I think the propaganda inspired by the Department of Defense was outrageous. It was completely wrong. But if you're talking about factual information, it was inadequate.

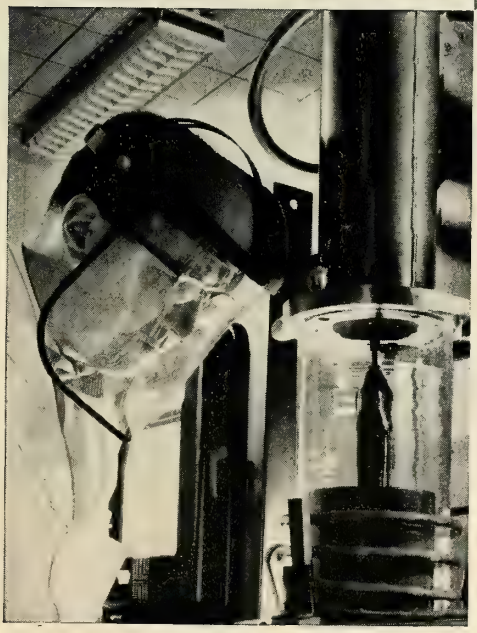
Q. **Are you referring to the actual coverage by the newsmen of the event itself?**
A. I think we're confusing propaganda inspired by the Department of Defense with factual information about the firing and possibility of success. The Defense Department failed to give a candid picture to the American people. If we're going to withhold information because of possible ill effects of the propaganda uses of it by the Department, we could withhold almost anything!

Q. **Do you think the so-called propa-**

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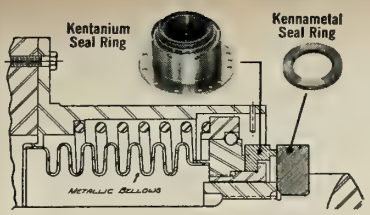
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ganda on the *Vanguard* project might have influenced the Russians to step up their own satellite development?

A. I don't think so. I don't think there's any evidence that Russia has accelerated her program. I think when she launched her *Sputnik* she was already committed to a rapid course.

Q. In other words, the fact that we publish information about a certain missile or a certain satellite in the future would not necessarily mean that the Russians will step up their own program?

A. I don't think so. I think Russia has demonstrated that she has the sense of urgency which we apparently lack, and she recognized fully the impact on other nations of demonstrating superiority in this field. I don't think Russia's program is geared to what we might be planning, but it's geared to her ability to do a job. She's going to make us look bad just as quickly as possible. Whatever we do is not going to affect Russia's program.

Since this interview with m/r, the Moss bill telling the Executive Branch that it cannot rely on the 1789 statute for holding back information from the public and Congress, passed the House and has been sent to the Senate. It was passed by a wide bipartisan margin.

The 1789 statute authorizes department heads to regulate the "custody, use and preservation" of documents. But the House Subcommittee on Government Information, headed by Moss, showed agencies relied on this language to hold back information.

Shortly after passage, Moss said President Eisenhower's recent directive to the Secretary of Defense to strengthen the Defense Department's control over public information is "dangerous." Censorship of opinions or facts that fail to fit "policy" already has reached an "alarming degree" under Assistant Secretary Murray Snyder, Moss said. The President has explained his directive as a move to curb interservice rivalry.

Moss will be chairman of a panel on "Freedom of Information"—June 5 at the First National Missile Industry Conference, Washington, D.C. Sponsors are the American Rocket Society and the National Rocket Club.

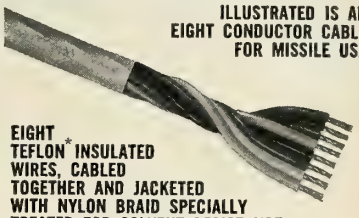
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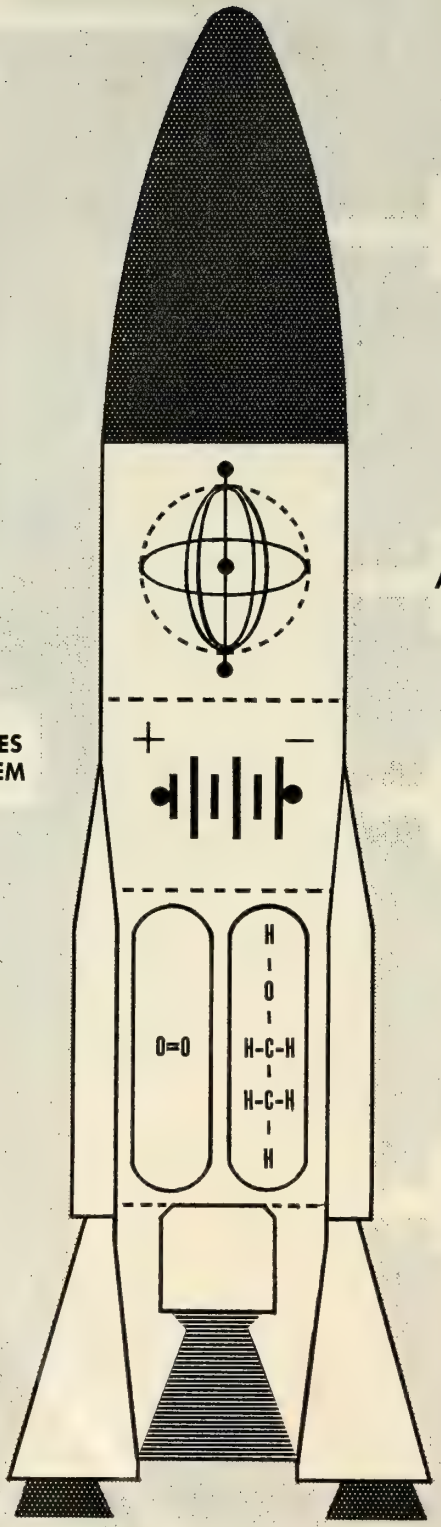
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NACA Probes Fluorine Uses

Operational hazards of high-energy propellants studied at Cleveland facility

by Alfred J. Zaehringer

A $2.5-MILLION LABORATORY, the Lewis Rocket Engine facility, has been placed in operation by the NACA at the Lewis Flight Propulsion Laboratory, Cleveland, Ohio.

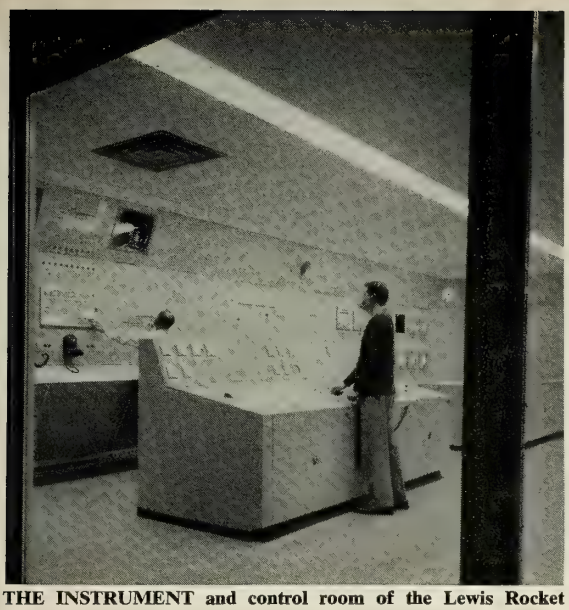
The new facility will be devoted to the development of new high-energy rocket propellants. NACA favors fluorine and has designed the laboratory with an eye to handling the hazardous and toxic material and its equally toxic exhaust. Components of the facility are: propellant supply and storage system, a thrust stand, silencing equipment, exhaust gas disposal system and an operations building which includes an instrument and control room.

Because of the high reactivity, handling fluorine is said to be more like working in a hospital operating room than in a machine shop. Fuels and oxidants, stored in tanks outside the test area, are brought to tanks near the test area, pressurized by nitrogen gas and then injected into the vertically mounted motor. The rocket motor fires directly into a closed silencer and scrubber. Current motors are at the 5000-lb. thrust level but this will be increased shortly to 20,000 lb. thrust.

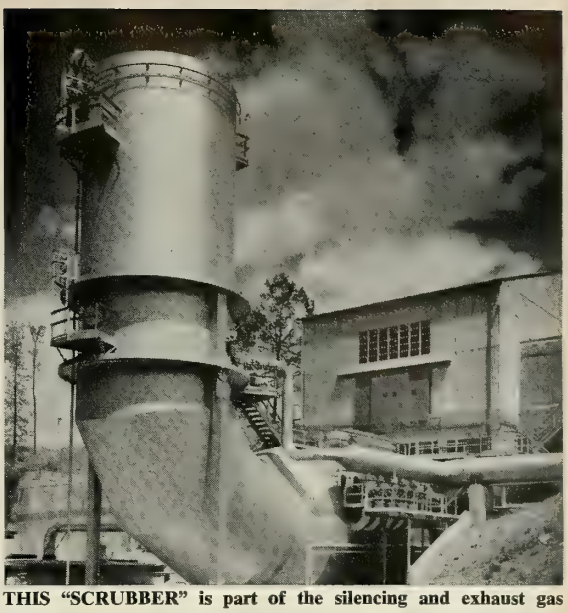
NACA is currently studying injectors—presumably for fluorine combinations—and the parallel sheet blocks give about 90 to 95% of theoretical performance. Present blocks are machined from copper. Some of the fluorine engines look as if they are made of welded tubing for cooling purposes. However, NACA says two big problems have yet to be licked—the high combustion temperature (some 2000-3000°F hotter than the oxygen-hydrocarbon combinations) and the toxic exhaust (HF with most hydrocarbon fuels). It thus appears that the ozone rocket is considerably behind the fluorine hardware development stage.

NACA also has displayed two working models of ion rockets. One jet is produced in an arc chamber by striking a high electric current between a tungsten cathode rod and a graphite anode nozzle. A working fluid is injected and passed through the nozzle forming a plasma jet.

Streams of 10,000-20,000°F have

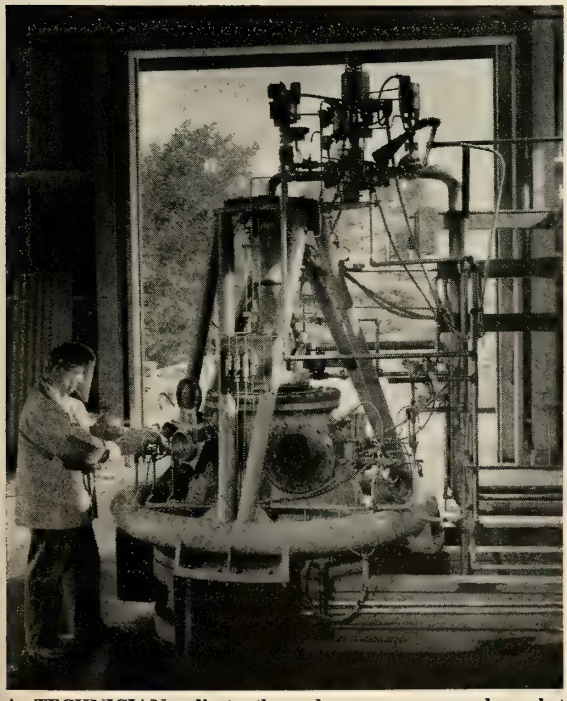


THE INSTRUMENT and control room of the Lewis Rocket Engine Research Facility is operations center during firings.

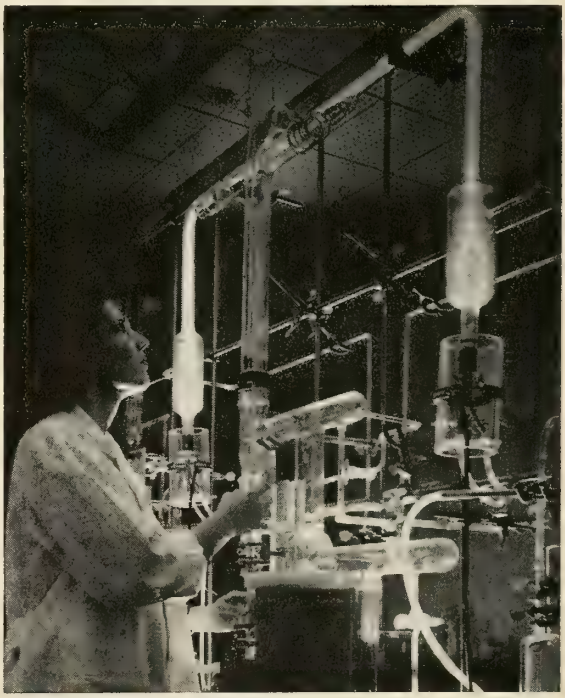


THIS "SCRUBBER" is part of the silencing and exhaust gas disposal system of the rocket engine static firing testing facility.

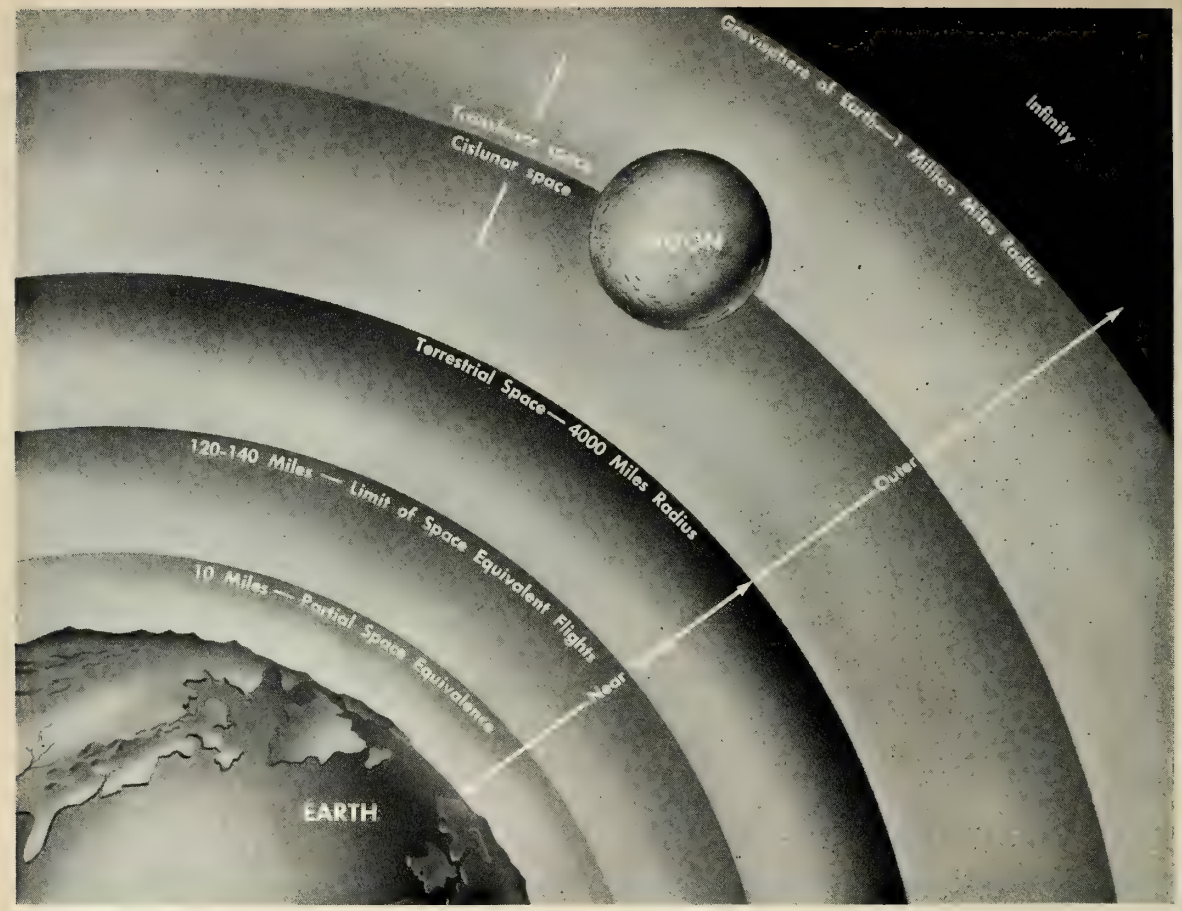
been produced and are currently being used to study the re-entry problem. The plasma jet is allowed to blast the nose cone of a missile model. Also demonstrated was an ion jet. Charged particles are formed in an electric discharge between two electrodes and are accelerated by a magnetic field. The thrust level was extremely small but large enough to operate a miniature low-mass pinwheel in a vacuum. Though NACA suggests both for outer space flight, it is agreed that package sizes to generate the necessary amounts of electrical power are still very unfavorable—especially considering that all such packages would have to be carried into space by chemical rockets.



A TECHNICIAN adjusts the valves on a research rocket engine mounted vertically within a test stand in the Lewis research facility.



A SCIENTIST compares materials under a barrage of atoms to determine which are more useful in missile and rocket manufacture.



Spatiography: Geography for Space

by Hubertus Strughold, M.D., PhD.*

NEVER BEFORE has the imagination of mankind been captivated so much by the concept of space. It is a concept that has appeared under a great variety of names: near space, outer space, deep space, free space, interplanetary space, cosmic space. But "space" is vast, even within our own solar system. From the standpoint of astronaustics, and especially of space medicine—or bioastronautics—we must specify just what is meant in terms of topography and environment.

Just as the traveler on the earth's surface used the science of geography for his orientation concerning the distance and conditions to be encountered on his journey, so does the astronaut need a topographical and environmental description of space. This might be called "spatiography"—for orientation, navigation, designation of the various kinds of space operations, and estimation of the medical problems involved.

At first glance, it may seem impossible to draw borderlines or demarcation lines for subdividing an environment distinguished by emptiness. There are, however, several possibilities.

• **Beginning of Space**—First question is "Where does space begin?"

This is the title of a paper published by the writer, with H. Haber, K. Buettner, and F. Haber in 1951, in which the concept of the functional borders between atmoshpere and space was introduced. In this publication, it was shown that the various atmospheric conditions necessary for manned flight come to an end at varying altitudes, some even within the lower regions of the stratosphere.

The final functional limit of the atmosphere is found at a height of 120 to 140 miles, where the atmosphere terminates aerodynamically. This is the dividing line between space-equivalent flights and true space operations—or between the aerodynamically effective air space and free space.

Now, what are the possibilities of subdividing, for astronautical purposes, the regions beyond this border?

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*Advisor for Research, School of Aviation Medicine, USAF, Randolph AFB, Texas.

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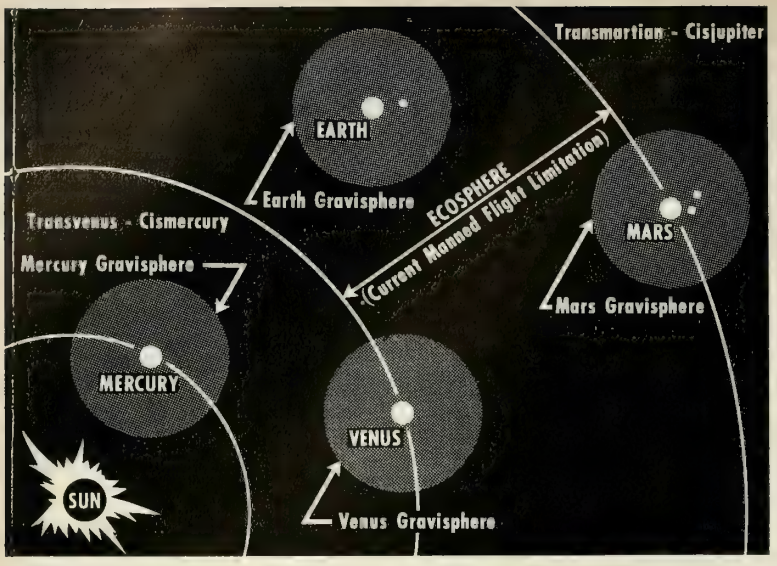
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. . . Spatiography: Geography for Space

We can speak of cislunar space, translunar space, cismartian, and transmartian space, as Krafft Ehricke has suggested. (Cislunar on this side; Translunar space beyond.)

• **Gravisphere**—Of special interest from the standpoint of navigation is the gravitational situation in space.

The gravitational field of the Earth, as of every other body, extends, of course, to infinity—but for the astronaut, the sphere of predominant gravitational attraction is of most importance in navigation.

It might be practical to call these gravitational control zones gravispheres. The gravisphere of the Earth extends to about 1 million miles, this is the arena in which satellites are conceivable. Escape velocity eventually thrusts a vehicle out of the Earth's gravisphere into the gravitational control zones of other celestial bodies.

Thus we can arrive at an astronautical subdivision of space, based on the extention of the gravitational territories of the various celestial bodies.

Of practical and vital importance to the astronaut are differences in the environmental conditions of space itself: the space environment in the vicinity of celestial bodies is different from that in free interplanetary space. It shows some peculiarities caused by the mere presence of solid bodies, by optical properties of the surfaces of such bodies and by forces originating in these bodies and extending into space.

In the vicinity of the earth for instance, we are protected by the solid body of the planet itself from cosmic rays and meteorites—just as we are protected in the lee of a house from rain, hail or wind. Other peculiarities of space environment, near the earth, are shadow and radiation.

The forces that cause special regional environmental differences in the space near the earth are those of the geomagnetic field. The magnetic field of the earth strongly influences the influx of corpuscular rays of solar and cosmic origin, by channeling them into the polar regions. The density distribution of these ray particles in adjacent space, in fact, shows considerable variations with the earth's latitudes.

For all these reasons, space in the vicinity of the earth is somewhat different from open interplanetary space.

To emphasize these differences, Krafft Ehricke has introduced the concept of the "terrestrial space" and assumes for it an extension of 1 earth radius, or 4,000 miles.

"Circumterrestrial space" might be another suitable designation. For this region, within which the earth's influence upon the ecological qualities of space is distinctly recognizable, it might be advisable to use the term "near space," and for the region beyond, the term "deep space" or "outer space."

• **Solar Radiation**—But outer space again shows environmental differences in various parts of our solar system. These are based on variations in the intensity of solar radiation as a function of the distance from the sun.

A vehicle in the neighborhood of Venus would receive about fifty times as much heat per unit of surface area each minute than a vehicle in the area of Jupiter. This is an important factor in climate control within the space cabin. A vehicle fitted for a trip to Venus would not be suitable for an excursion to Jupiter, just as an expedition outfitted to hunt alligators in the jungles of the Amazon could not be sent to hunt polar bears in the Arctic. Any vehicle entering the intra-mercurian space would finally run into a kind of solar heat barrier.

With respect to visible radiation, or light, the "sky" in space is dark everywhere. However, the illumination received from the sun varies considerably. In the orbit of Mercury, it amounts to almost 80,000-foot candles while at the remote distance of Pluto, it is only 8 foot candles.

Finally, the ultraviolet range of solar radiation, which is chemically very active, has strongly influenced environmental conditions on the planets. This is shown by the division of their atmospheres into an inner oxygen belt, and an outer hydrogen belt. The first includes Venus, the Earth, and Mars. The second comprises the planets from Jupiter to Pluto. Spatiographic ecology, then, covers two areas: the ecology of space itself, and the ecology of the planets, or planetary ecology.

• **Ecosphere**—For manned space operations there seems to be—at least for the time being and in the near future—a limited area in the solar system with regard to the ecological conditions of space itself and the planets.

This is a kind of ecosphere, or a function of the distance from the sun and the resulting radiation intensities. This sphere includes the region from Venus to Mars.

We get a dramatic impression of the radiation intensity of the sun in both respects by comparing the size of the sun as seen from the various planets. For instance, from the distance of Pluto, the sun would not appear larger than the evening star (Venus) appears to us on earth.

For hundreds of years, astronomers have been mapping the stars, measuring the distances to them, and defining their motions. The astronomer performs these magical feats from afar while he sits behind his telescope in a well-tempered observatory, surrounded by the fresh air of Texas or California mountains.

By contrast, the astronaut will leave the life-supporting air of our planet and venture far into space, enclosed in his own little "earth." He has to know where he is going, into what physical environment. He needs as guide a "geography of space," or spatiography, based essentially on ecological considerations concerning space itself and the planets.

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2. **DEPENDABILITY.** Gas turbines are the simplest of all heat engines. There are few moving parts and no complicated cooling system. Overhauls are infrequent, maintenance is easy, routine servicing can be completed in a few hours.

3. **LIGHT WEIGHT, SMALL SIZE.** Solar gas turbines are many times smaller... and weigh up to *forty times less* than conventional engines! All essential piping and duct components are a part of the engine. There are few accessories and controls.

4. **PORTABILITY.** Compact and lightweight, Solar turbines can be easily mobilized for quick transportation to remote locations.

5. **ADAPTABILITY.** Versatile Solar turbines can provide power for virtually every phase of missile support—such as erecting and aligning, fueling, calibration, checkout and launching. Both shaft power and compressed air are available for important hydraulic, electric, mechanical, and pneumatic applications.

6. **USES ANY FUEL.** Solar gas turbines can operate on almost any available fuel—including gasoline, kerosene, natural or manufactured gas and diesel oil—greatly simplifying logistics for remote missile operations.

Portability, instant power and 100% reliability are continuing problems in the critical area of missile support. For more information on how Solar gas turbines can help solve these problems, write to Dept. F-11, Solar Aircraft Company, San Diego 12, California.

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Air on Mars?

Yes—But . . .





It seems pretty certain there's "air" on Mars—but it is in such small amounts that observers don't know how much.

In simple terms, the Mars visitor won't be bothered by the humidity, or by breathing either, for a long period. Both water and oxygen are present, but in such small quantities as to be virtually undetectable by present measuring methods. Same goes for gases like argon, neon, krypton and others.

Plants, like people, would probably find breathing a problem too, for the presence of carbon dioxide is still to be confirmed.

Telescopic observations suggest that Mars has an atmosphere similar, though more transparent than that of the Earth. For more specific information on the Martian atmosphere, astronomers have relied mainly on the spectrograph, though results so far have been inconclusive. The persistence of inconclusive results (despite increasing sensitivity of observing techniques) has led to lower estimates of the quantities of gases, such as oxygen, water vapor and carbon dioxide.

During the 1956 close approach of Mars, two husband-and-wife teams—C. C. Kiess, H. K. Kiess, C. H. Corliss, and E. L. R. Corliss—participated in an investigation sponsored jointly by the National Geographic Society and the National Bureau of Standards.

Using more sensitive instruments than ever before, scientists took their observations from the observatory operated by the U.S. Weather Bureau on Mauna Loa volcano in Hawaii. Other infrared spectrograms were made at the Georgetown College Observatory in Washington, D.C. The investigation concentrated mainly on a search for oxygen and water vapor.

Based on measurements, there is less H_2O in the Martian atmosphere than there is in a film of water 0.08 mm (1/300 in.) thick.

These results are not incompatible with the presence of water vapor in amounts sufficient to explain the transport of water from one polar cap to the other.

Results do raise the question, however, whether spectroscopic tests used are delicate enough for the purpose. Both theory and experiment indicate that much stronger bands occur farther in the infrared, which may be helped by spectrographs mounted in high-altitude balloons, rockets or artificial satellites.

On earth, the light from Mars is really a composite of three different spectra, containing absorption lines originating in the reversing layer of the Sun's atmosphere, Mars' atmosphere, and in the Earth's atmosphere. The wavelengths of the solar lines are accurately known.

For the much more difficult task of distinguishing lines due to Mars from those due to the earth, two methods have been in use.

One method is to observe Mars at "opposition" — when Mars, Earth, and Sun are most nearly in a straight line, with the Earth between the other two. Mars is then at its brightest. Because the distance between Mars and Earth is neither increasing nor decreasing, absorption lines originating in the atmosphere of Mars will not be separated by Doppler shift from those lines originating in the earth's atmosphere.

The second method is to observe Mars at some time before or after opposition, when the Doppler shift would clearly separate Martian and terrestrial lines. Then —if there is oxygen in the atmosphere of Mars—one might expect the oxygen lines caused by the Earth's atmosphere to have faint companions, separated by the amount of the Doppler shift.

The second method was used in the latest investigation. Spectrograms were obtained about seven weeks before opposition at Mauna Loa, and about six weeks after opposition at the Georgetown observatory. In the earlier spectrograms, the Doppler shift was 0.22 A (angstroms) toward the short wavelengths, and in the later ones, 0.25 A toward the longer wavelengths.

The new study of the Martian spectrum was undertaken in order to see what could be done with the newer aids to observation. These include better diffraction gratings and optical systems, faster photographic plates, and more accurate guiding mechanisms for prolonged photographic exposures.

The numbers of molecules of both gases are too small to be detected with the equipment used.

The spectrograph used in the present investigation could detect no H_2O bands beyond the one at 0.823 microns (1 micron=10,000A).

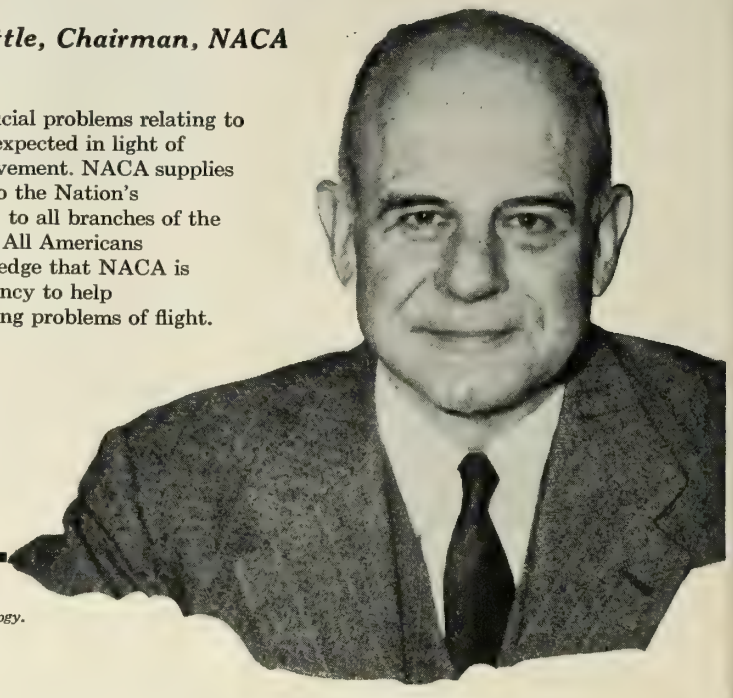
National Bureau of Standards Technical Report 2192 provides detailed data on the investigations.

A message for young physical scientists & engineers

from James H. Doolittle, Chairman, NACA

Future breakthroughs on crucial problems relating to aircraft and missiles can be expected in light of NACA's long record of achievement. NACA supplies advanced research findings to the Nation's aircraft and missile industry, to all branches of the military, and to the airlines. All Americans can be assured by the knowledge that NACA is working with a spirit of urgency to help solve the current most pressing problems of flight.

James H. Doolittle



James H. Doolittle, Chairman, NACA;
Sc.D., Massachusetts Institute of Technology.

NACA has a staff of 7,750 research scientists and supporting personnel spread among centers on both Coasts and in Ohio. NACA staff members in pursuit of new knowledge have available the finest research facilities in the world, including several of the largest and fastest supersonic and hypersonic wind tunnels, hot jets, a fleet of full scale research airplanes, which will include the X-15, hypersonic ballistics ranges, shock tubes, a nuclear reactor establishment, rocket facilities, a research missile launching site, tracking devices, and the most advanced mechanical and electronic computers.

NACA Fields of Research Include: Aerodynamics, Aircraft and Missile Structures, Materials for Aircraft and Missiles, Automatic Stabilization, Propulsion Systems, Propulsion Systems Structures, Rocket Systems, Solid State Physics, Fuels, Instrumentation.

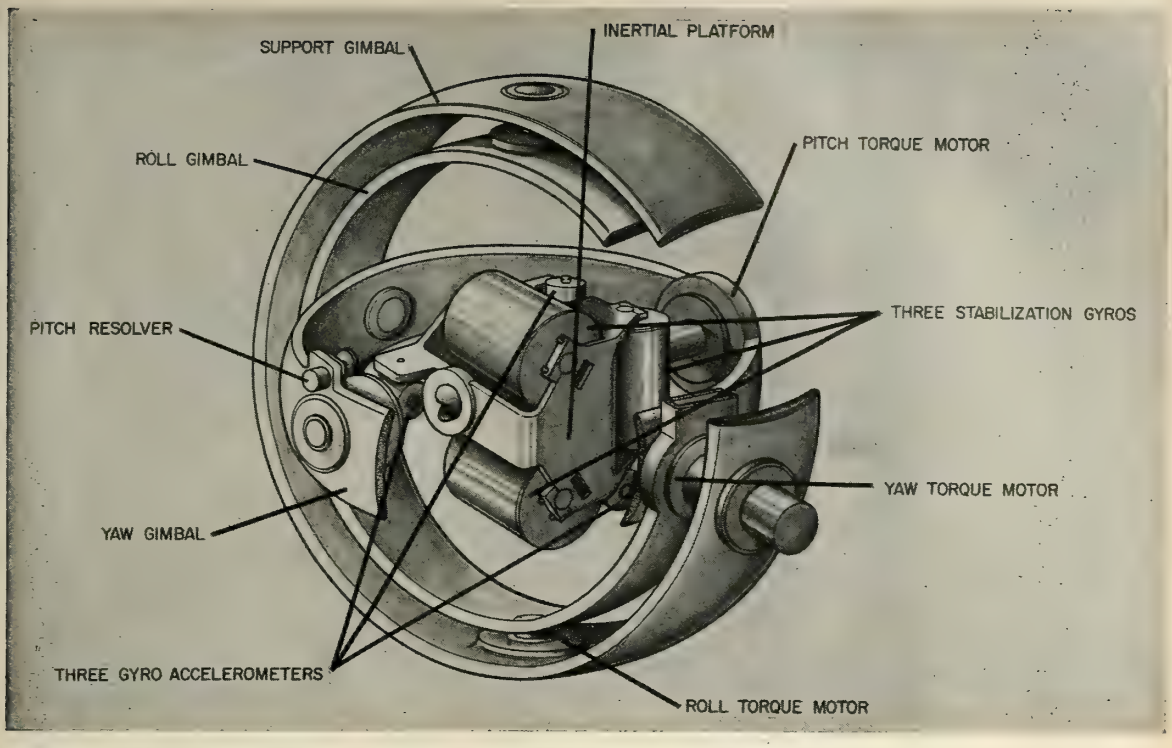
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Outside-In Gimbaling Used In Thor

Optimum accuracy to be more important than weight considerations in guidance device

Ed. Note—The February issue of m/r (p 199) carried a description of the type of stabilized platform used on the Jupiter missile written by the Deputy Director for Guidance and Control, ABMA, F. K. Mueller. Because of the basic difference in concept between the Jupiter and Thor stabilized platforms, AC Spark Plug division of General Motors, manufacturers of the Thor guidance system, was invited to describe the Thor stabilized platform. Briefly, and to repeat from February, the Thor platform, like most units with unlimited travel in all three degrees of freedom (as in aircraft, land and sea applications), is gimbaled from the outside-in while the Jupiter platform departs from convention by gimbaling on a central core (from the inside out). Here, R. G. Brown, Thor Engineering Program Director for AC Spark Plug, describes the Thor platform and outlines some of the history preceding the choice of such a platform.

THE MOST IMPORTANT REQUIREMENTS placed upon the first inertial systems developed for manned long range bombers were those of unrestricted operational maneuverability and long flight times.

These two primary factors combined with the current development of gyros, accelerometers, and airborne electronic computer components, logically lead to the use of the external or outside-in gimbal system.

Pioneering work in development of inertial systems for long-range manned aircraft came out of the Instrumentation Laboratory of the Massachusetts Institute of Technology. Taking off from this study, AC Spark Plug engineers went to work on a basic system design that recognized the development status of floated gyros and analog computers, and employed these components to promote optimum accuracy rather than minimum weight.

Gyro drift characteristics were such that a true inertial or untorqued gyro reference platform was necessary. This, coupled with the requirement for unrestricted maneuverability, required external gimbaling, since this design approach readily provided wide angular freedom about more than a single axis.

Thus, the gimbal structure could perform a portion of the required coordination transformations. This mechanical analog computation was now possible with an accuracy that could not be matched by available airborne analog or digital computers.

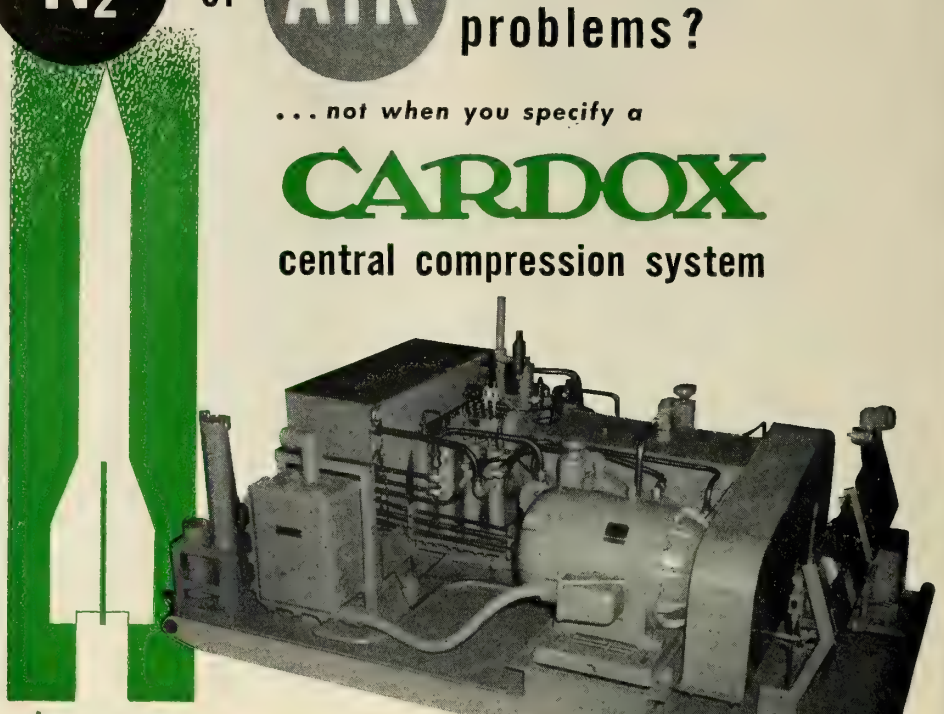
Subsequent laboratory and manned aircraft flight testing showed that steady state deflections could be limited to less than a fraction of a minute by proper design of hollow box-section aluminum gimbals. During the course of the development program, design data was compiled on the stability of alignment of inertial sensor elements, the sensitivity of precision machining materials to thermo-cycling, and the vibration characteristics of the mechanical structure. This information formed a basis for de-

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. . . gimbal system

sign in later development work on inertial systems for both air-breathing and ballistic missiles.

• **Ballistic programs**—The advent of Air Force-sponsored ballistic missile programs provided impetus to refining inertial sensor elements and mechanical packaging techniques. The large-sized gimbal systems used successfully in manned bombardment aircraft were known to be incapable of maintaining the necessary accuracy of inertial sensory alignment when exposed to high acceleration and vibration.

However, with the development of smaller gyros and accelerometers that had the required system performance capability, application of external gimbaling techniques in the design of missile guidance systems was again found to be practical.

It was natural in following development programs, to carry over as much of the experience gained in the use of externally gimbaled platforms as could be applied to ballistic missile systems. This was particularly true where abbreviated schedules reduced the time for development of a production prototype.

Thus, initial design efforts in the area of missile guidance revolved around the use of smaller gyros and accelerometers in conjunction with familiar and proven package designs.

The fact that external gimbaling could withstand high vibration and sustained acceleration with a conservative design margin was demonstrated by centrifuge vibration and rocket sled tests, as well as actual missile flight tests.

Where highly precise and stable mechanical alignment of the inertial sensing elements is essential, it has been found advantageous to use high density packaging techniques. This can best be achieved by applying the external gimbaling approach.

High density packaging is the practice of integrally mounting the stabilizing gyroscopes and acceleration sensing instruments in a tight cluster on a rigid platform. The use of precision machining and lightweight materials has made possible the design of a high density inertial instrument package, that is considered capable of meeting both weight and accuracy requirements.

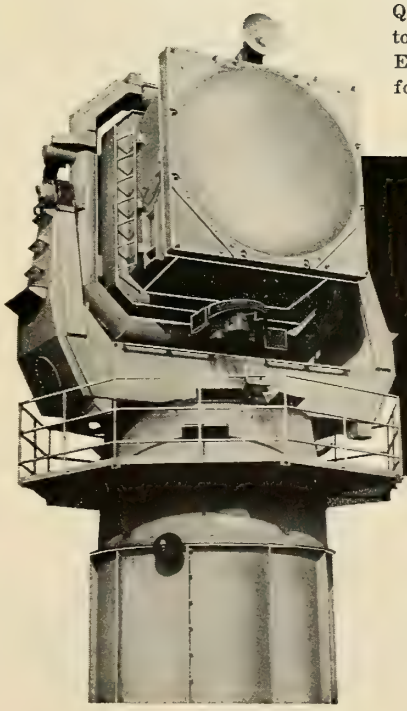
Having attained the desired inertial package design, it is relatively easy to wrap two additional gimbals around it and provide additional degrees of freedom for preflight erection and in-flight stabilization. Use of newly engineered

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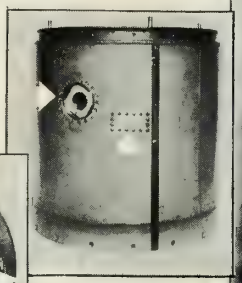
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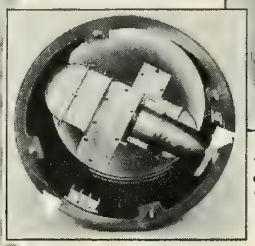
U. S. Navy uses SEELSKREWS in Aerobee Rocket

The U.S. Navy's Aerobee High Rocket is tracked from below by means of beacon slot antennae. Sixteen APM SEELSKREWS (self-sealing screws) hold and seal each of eight built-in antennae flush against the skin—a total of 128 SEELSKREWS per rocket.



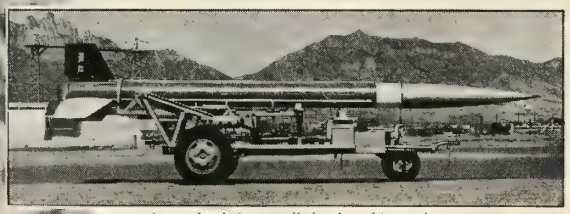


Nose cone extension, 16 SEELSKREWS maintain leakproof sealing.



Two beacon slot antennae mounted on interior of skin.

One of eight antennae mounted in two rocket sections.



Aerobee rocket being trundled to launching pad.

In this application APM SEELSKREWS are used to maintain pressure integrity from ground level to altitudes of 160 miles—virtually a complete vacuum. SEELSKREWS resist vibration and shock as the rocket is trundled to the launching pad . . . and even maintain their sealing action throughout the critical period of powered flight. In other applications, SEELSKREWS have held pressures in excess of 500 psi.

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cross sections for these outer gimbals has resulted in a rugged gimbal system. Machining tolerances for the two outer gimbals need not be as stringent as for the inner rings, since they perform only a stabilization function and not a basic alignment reference function.

• **Gimbal unit details**—The accompanying sketch shows the essentials of a typical outside-in gimbal unit such as is presently being produced by AC for ballistic missile use.

The inertial instrument package includes three single-degree-of-freedom floated gyroscopes mounted directly to machined surfaces on the platform casting with their input axes mutually perpendicular.

The relative orientation of output and spin axes has no direct effect on system performance, so that orientation can lessen gyro drift effects and thus add to the accuracy of platform stabilization.

Also mounted directly to the platform casting are three gyro accelerometers oriented so that their input axes are mutually orthogonal and parallel to the stabilization gyro input axes.

The high density packaging approach minimizes the required number of separate parts by mounting the elements of the accelerometer drive servo directly to the single platform casting, rather than placing them on an intermediate support member.

Elimination of mounting supports and other parts not only achieves an increase in reliability, but also provides insurance against a shift in accelerometer alignment during field use. Missile applications where nut-and-bolt or screw-type mounting of critically aligned inertial members is employed are known to be prone to mechanical slippage.

In addition, such mounting methods often require highly skilled personnel using precision equipment to establish an accurate alignment between inertial elements.

Use of the inertial platform as an integral mount—easily accomplished with the external gimbaling approach—places the burden of alignment accuracy on basic machining tolerances, rather than on less easily controlled techniques of assembly.

• **Control simplification**—A by-product of high density packaging is simplification in thermal environmental control.

In ballistic missile applications, constant readiness requirements may dic-

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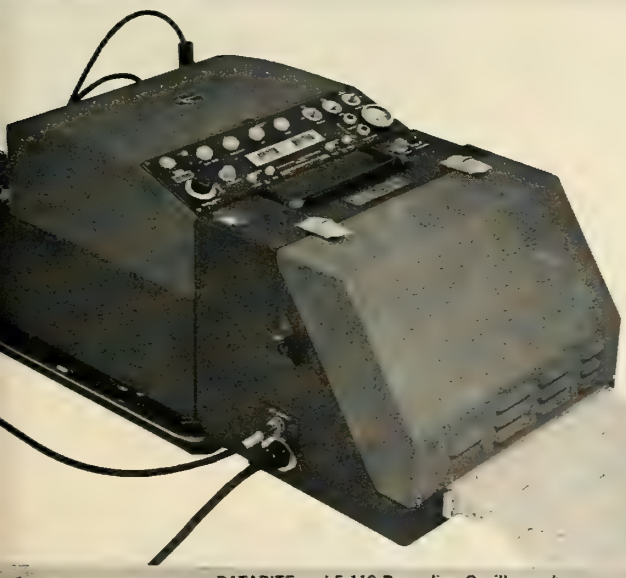
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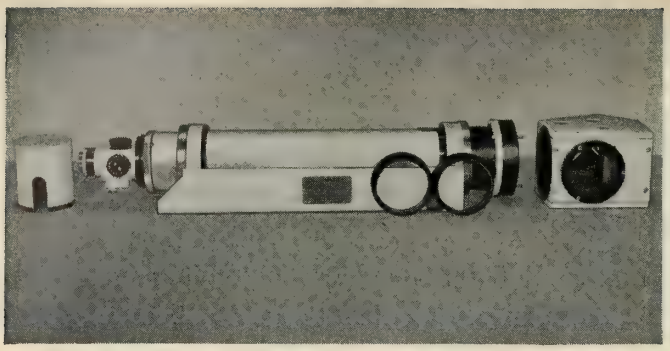
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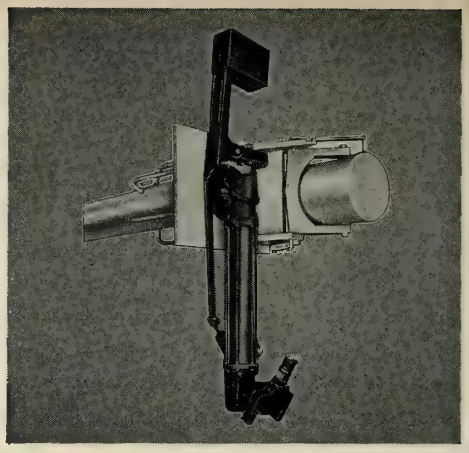
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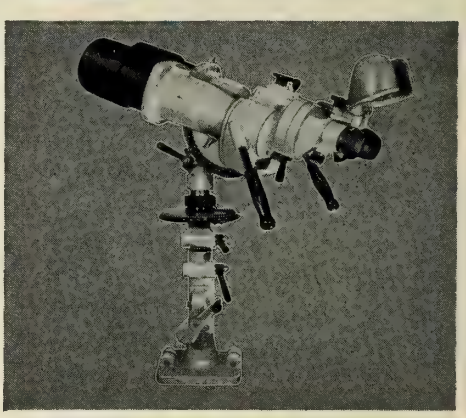
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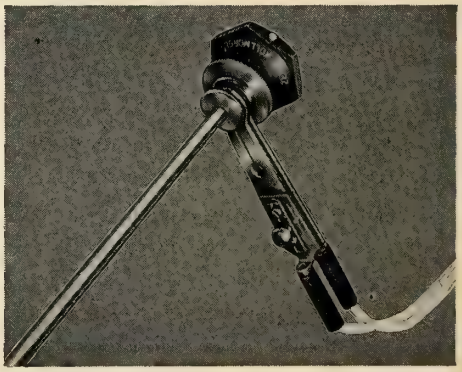
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tate long-time stability of gyro and accelerometer characteristics. Stability of these inertial elements is extremely desirable from an operational standpoint: re-calibration and alignment checking of these units (often exacting procedures) are not necessary to achieve the missile flight objective.

Experience has shown that the required stability is most easily achieved by minimizing thermal cycling and gradients. The high density packaging offered by the outside-in approach generally reduces the volumetric requirement for thermal control, and hence simplifies establishment of a satisfactory temperature environment for the inertial sensing elements.

• **Design advantages**—Another advantage is that the gimbal rings which surround the inertial package provide a natural support frame for direct-drive torque motors.

The elimination of backlash and gearing inertia problems are advantages well known to designers of high resolution stabilization systems.

An objection to the use of the direct-drive motor has been the complexity and size of the associated power amplifier unit.

In recent years however, the reduction of load inertia attendant with miniaturization of the gimbal package, coupled with the development of high power transistors, has resulted in small and efficient amplifier units capable of powering the direct-drive mechanism.

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The accompanying drawing shows the pitch resolver used for the resolution of gyro error signals as typical of this type of component mounting.

While this article has dealt primarily with the advantages of external or outside-in gimbaling, there is much to be said of the inside-out approach, the gimbal-less approach, and other inertial sensor support techniques.

Each must be weighed on its own merits with a critical look at specific system requirements, status of development of primary inertial sensor units, in-house design and manufacturing experience, and the time allotted for development work and investigation of alternate approaches.



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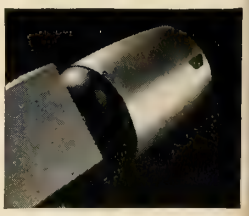
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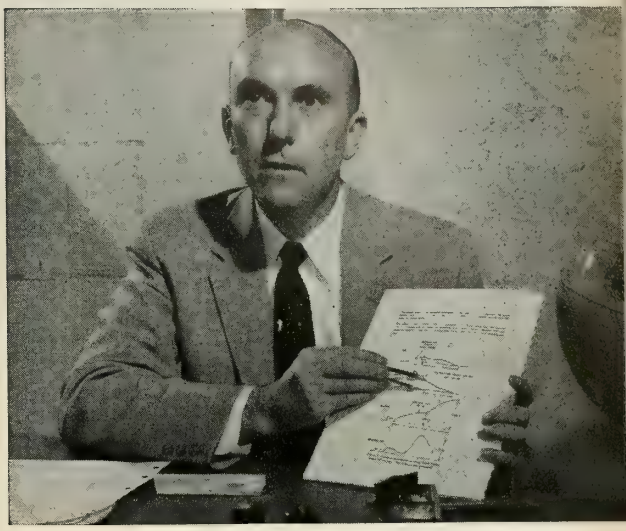
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Robert P. Haviland –

Mr. Missile Reliability



by Erica Cromley

PROGRESS has always leaned heavily on two types of people: the thinkers and the doers. Second to these are the teachers of the thinkers and doers—those who spark creative ideas in others and spur them into action. The world has had few who have combined all three. Robert P. Haviland is such a man.

As Advanced-Systems Planning Engineer—Satellites at General Electric's Missile and Ordnance Systems department, Haviland puts his rare talents to work on advanced satellite systems and on the creative potential of the young engineers which comes to fruition under his guidance. One company official said of him recently: "He has a unique way of laying out facts which tends to make the 'green' engineers creative."

Haviland, 44, has the type of mind that can get to the heart of a problem immediately. He has a vast store of knowledge in all the scientific and engineering disciplines surrounding missile work: electronics, electromechanics, propellants, instrumentation, testing, guidance, stress and human engineering factors.

There are any number of men who are more competent in each field, but few men can relate all fields as Haviland can.

His scope is vast. It is buttressed by a fantastic memory, constant study, an avid interest in his field and attention to details. His mind is always racing ahead. He is essentially a planner.

As early as 1946, he worked on extension of missile technology into the satellite field at the Bureau of Aeronautics. He then went to General Electric in 1947 as flight test engineer on such projects as *Hermes* and other extensions of the V-2.

On February 24, 1949, a modified V-2 *Bumper* reached a peak altitude of 242 miles. This was man's first toehold in space. Willey Ley, space lecturer, said in his book ROCKETS, MISSILES and SPACE TRAVEL: "Robert P. Haviland, who had been project engineer of the experiment, probably did more than any other single man to bring this shot about."

• **Christened**—References to Haviland as Mr. Missile Reliability go back to 1951 when he began his intensive study of missile failures. "I was greatly disturbed . . . every rocket I had worked on had at least one thing go wrong with it. For five years while I was flight-test planning engineer and systems engineer, I worked on reliability. I have finally evolved what I call a theory of reliability but I have not yet had time to verify it."

(This last refers to his report for GE, "Introduction to the Theory of Reliability"—an attempt to set forth basic principles which will determine whether a system will work before it is formally tested.)

Haviland's interest in space received its initial thrust during his college days at the Missouri School of Mines, Rolla, Mo., when much of his spare time was spent reading science fiction.

In 1939, when he received his BS in electrical engineering, he kept his feet on the ground as a geophysical engineer in field and development operations for a Texas Oil company.

During World War II, as a lieutenant commander in the Navy, Haviland served as project officer on radar beacons at radiation labs at MIT and the Bureau of Aeronautics. It was while with BuAer, when reports first came in on the V-2, that his interest in missiles was fired.

In 1945, after careful study of all the data available, he wrote a long memo to the Chief of BuAer telling him what could be done. This memo resulted in expansion of the bureau's rocket program which, even at that early date, included satellites.

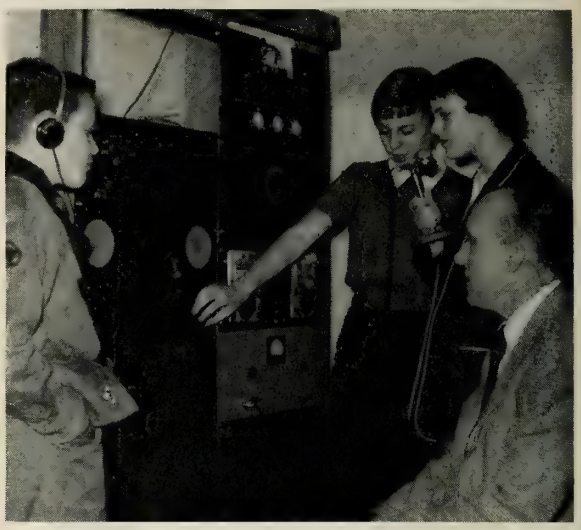
Haviland early became concerned about America's status in the race to enter space—and the fact that the public still regarded space programs as "Buck Rogers stuff."

THE HAVILANDS practice the Cha-cha-cha, taught at a local dance class.





FAMILY PROJECTS. At home with the Haviland clan, a new world globe acquires a fresh paint job.



RADIO HAMS. The family tunes in regularly to Haviland's homemade radio set.

In September, 1957, a month before the launching of *Sputnik* I, Haviland warned, "We have grossly underestimated not only the potentialities of other countries, but also their rate of development and the impact of that development on the rest of the world.

Mere spending of money will not be enough. We need more intelligence and wisdom in order to determine the right way to spend money."

• **Achievements**—Haviland has written many papers which have received widespread acclaim, but four areas of his work stand out:

1945—A complete examination in the field of satellite vehicles for the Navy Department which led to a train of studies by various U.S. organizations.

1955—A paper on the "Application of the Satellite Vehicle" before the American Rocket Society, in which he critically examined the question of what will be done with space travel once it is achieved.

1957—Proposal of three large space stations as communications satellites for radio and TV in America, Europe, Asia; at the Congress of International Astronautical Federation in Barcelona, Spain.

Recently—The technical study of the communications proposal.

Haviland, the man, feels keenly the responsibilities of Haviland, the scientist. Basically shy and introverted, he is given to meditation about man's role in the universe and whether he will fulfill it. "We have to find out why mankind is here or we are not going to be here," he said recently. "Space offers man an alternative to destruction to satisfy his drive to conquer. If we direct our energies up there, we won't be destroying each other down here."

He feels strongly about the dignity of the individual. "Me-too-ism is the worst danger to our American civilization and right now, it is a very popular concept. We have got to stop looking down on people because they're different. Creativity requires an atmosphere conducive to inquiry, independence and analysis."

However, Haviland is a proponent of moderation ("my byword," he says), and is concerned that we don't swing too far the other way. "Until recently we have not emphasized science enough. Now the danger is that we may emphasize it to the exclusion of other things just as important."

He feels that young people should be taught to express themselves adequately; while there should be increased emphasis on science there should be similar emphasis on English. "You can give young people a tremendous amount of scientific background, but, if they do get creative ideas and cannot adequately communicate them to other people, they are useless."

• **No chips off the block**—His three children have been brought up with emphasis on family intercommunication, but so far there are no signs of following pa's professional footsteps. They are happy, imaginative youngsters.

Kay, 17, a senior in high school, wants to be a librarian. Jean, 15, a high school sophomore, has her sights set on a nursing career. Jon Robert, 12, is no further out of the atmosphere than airplanes, his hobby; and boy scouting, his avocation.

Haviland met Opal, his brunette wife, during his early college years at Central Wesleyan College at Warrenton, Mo. They were both working their way through college—she as secretary to the college president; he as a movie projectionist in a local theatre.

The Havilands' contemporary house in Radnor, Pa., just outside Philadelphia, is their 23rd dwelling place in 18 years.

The Havilands don't get as much time together as they would like because of the rugged traveling schedule that goes with a scientist's job.

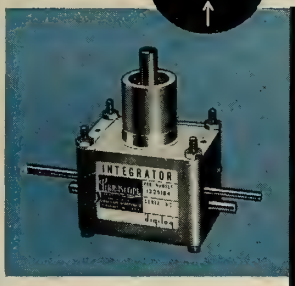
Family projects when they are together include: working the ham radio set that Haviland put together; building furniture (23 pieces in the last few years, including a space-flight design mosaic coffee table); painting a three-dimensional relief model of the earth; and outdoor cookery on the terrace.

Last year the Havilands took a dance course which they try to put into practice at least once a month. No community joiner, Haviland's one exception is a local swim club where he exercises.

He is active, however, in professional organizations: American Institute of Electrical Engineers, American Rocket Society, Franklin Institute and British Interplanetary Society. He is also on m/r's advisory board. Just recently he was elected to membership

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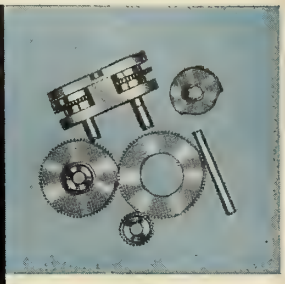
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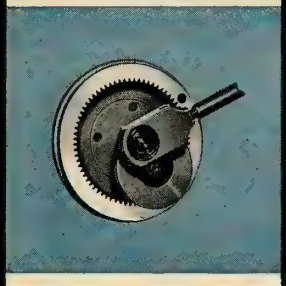
Flow Computer... extracts square root and continuously integrates both differential and static pressures for applications such as orifice measurement of fluids.



Custom Gears; Limit Stops, Shafts, Coupling and Cams... for computer, servomechanisms and instrument applications.



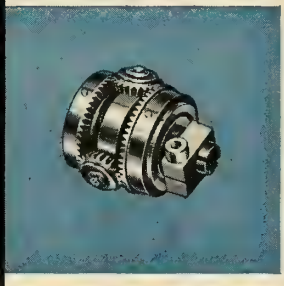
Analog Digital Converters... for converting shaft position to digital information available in Binary, Gray code or Binary decimal. Also Sine Cosine functions.



Sine Cosine Mechanism... for problems of changing variables involving vector components, range and bearing computations, sight computation, etc.



Linkages... for computing equipment; precision addition, subtraction linkages; multiplying linkages and function generators with displacement outputs.



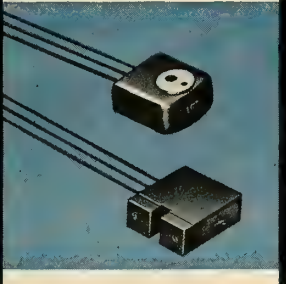
Hollow Shaft Differential... offers greater versatility in summing angular shaft positions; Hollow Shaft reduces breadboard and production costs.



X-Y Plotter and Recorder... for point or continuous plotting, with positive mechanical drive in recording graphic data. Several models and accessories available.



Magnetic Storage Drum... for medium storage applications; capacity 131, 072 non-volatile bits; drum speed 3800 rpm; clock frequency 130 kc.



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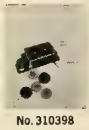
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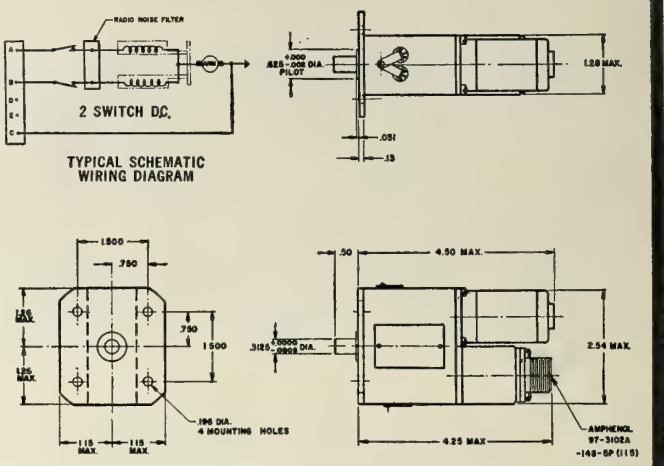
SERIES R12

100 in.-lb. max. op. capacity—26 v d-c or 400 cycles a-c

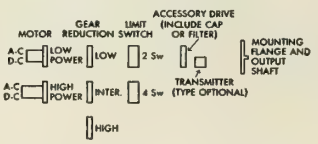
DESCRIPTION:

1. Actuators are designed to meet requirements of MIL-A-8064A and MIL-E-5272A. RD Series—motors are designed to meet requirements of MIL-M-8609 (26 v d-c split field series wound reversible intermittent duty motor with magnetic brake). RA Series—motors are designed to meet requirements of MIL-M-7969 (115v 400 cycles a-c single phase reversible intermittent duty motor with magnetic brake).
2. Actuators include internal starting capacitor or radio noise filter per MIL-1-6181B, limit switches externally adjustable throughout stroke, and non-jamming mechanical stops.
3. Operating strokes from 20° to 270° are available. An additional 10° of overtravel is provided. If intermediate position switches are used, operating strokes of up to 70° either side of intermediate position can be achieved.
4. Maximum operating load—up to 100 in.-lb.* Ultimate static load—up to 200 in.-lb.†
5. Weight—approx. 0.9 lb: for RD Series; 1.1 lb. for RA Series—includes mounting flange and output shaft shown. Weights for special mounting flanges, output shafts, electrical connectors or transmitters will be furnished on receipt of applicable specifications.
6. Electrical connector is shown in standard position, but may be located on other surfaces for special applications.
7. Actuators are available with load limiting devices, intermediate positioning switches, and thermal overload protectors.

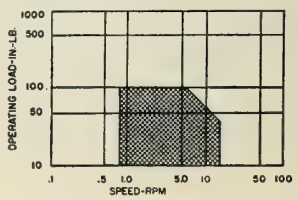
*Depending on motor and gear ratio selected
†Depending on gear ratio selected



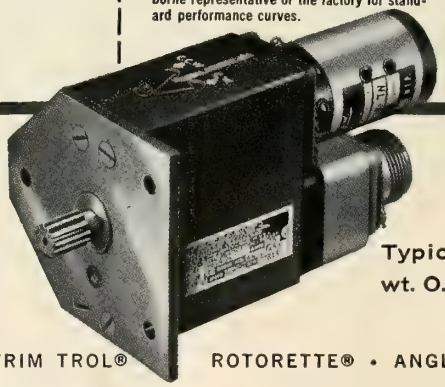
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Typical RD/RA-12 Module
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in the national electrical engineering honor society, Eta Kappa Nu.

• **Bookworm**—Young Haviland grew up on a farm in Patmus, Ohio, but his mind was not on farm chores. "When it was milking time they could never find me. I was usually off somewhere with a book." Kid games and horseplay never interested him. Haviland sopped up information from every science and adventure book he could get his hands on. He was obsessed with the "why" of things. At age eight, he took the alarm clock apart to find out what made it tick—but couldn't get it back together again.

A sound tanning might have turned the budding scientist to safer juvenile pursuits and the world would have been the poorer. Instead, father Haviland expressed "mild annoyance" and the subject was dropped.

His father did, however, insist he learn a trade, and saw to it that Haviland absorbed the fundamentals of carpentry—a skill he now keeps sharpened on family furniture building projects.

• **Future pursuits**—Haviland describes his present position as one without assignment. "My job is to think about the future." Future thoughts now are on commercial uses of satellites. Of these, Haviland is concentrating on three: communications (for international TV reception), meteorological (more accurate weather forecasting) and geodetic (more accurate mapping of the earth).

The space scientist predicts that within 10 to 15 years Americans will be tuning in their TV channels to Buenos Aires and London as nonchalantly as they flip their set to the local stations today.

These and other space vehicles are the subjects of Haviland's thoughts as he postulates the problems involved with their achievement.

Haviland's working day is spent in a small white office on the third floor of GE's plant at 3198 Chestnut St., Philadelphia. But his mind is 4,000 miles up in space—and five to ten years ahead of the engineers who will one day convert these thoughts to the instruments by which man will break loose from earth and fly out into space.

• **Point of no return**—An admirer of Haviland recently asked him, if, since his working day took him so far out into space, he had any difficulty coming back to earth at quitting time.

"Who comes back?" Haviland replied.

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Noise Figure	12-14 db
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Input Impedance	50 ohms
Output Impedance	50-75 ohms
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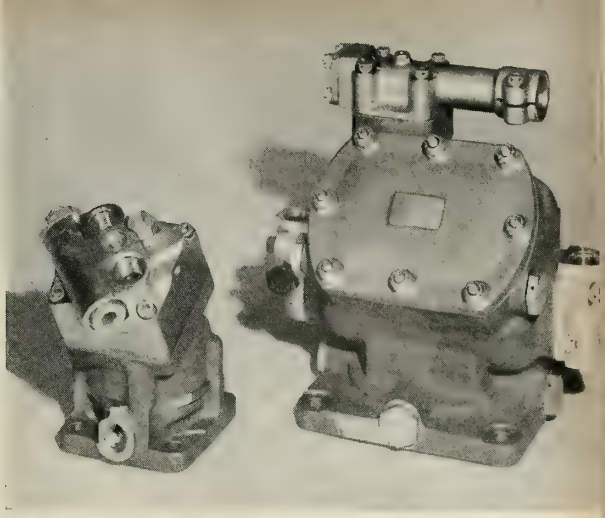


FIG. 1. Comparison between standard and miniaturized variable-delivery pumps of same output. New design saves 2.3 lbs.

by William Patterson*

EVERY REDUCTION in the weight and size of a missile or rocket component makes it a little easier for the vehicle to penetrate the earth's atmosphere.

At Vickers, Inc., a significant contribution to hydraulic component weight and size reduction was made when recent tests were completed on a new variable delivery pump with a 100% increase in power-to-weight ratio. With today's missiles and rockets carrying as many as 10,000 separate assemblies, miniaturization of components is an important phase of development.

• **Figure 1** shows the comparison between a standard size variable pump and the miniaturized version capable of the same output. This miniaturization of the variable delivery pump represents a 48% weight reduction and 70% smaller envelope.

This means a savings of approximately 2.3 pounds without sacrificing volumetric or overall pump efficiency. Reliability and response characteristics equal or exceed those of the standard variable hydraulic pumps now in use on aircraft and missile applications.

These facts and figures become particularly impressive when it is considered that for every added pound of component weight, a missile's gross weight is increased 30 to 50 pounds. Since liquid fueled turbines have a high specific fuel consumption, and in many cases are used to drive hydraulic auxiliary power units, high pump efficiency and lower weight can be translated into less fuel carried or longer burning time.

If the missile hydraulic accessory power unit is battery powered, the same

*Senior Staff Engineer
Aero Hydraulics Division, Vickers Incorporated

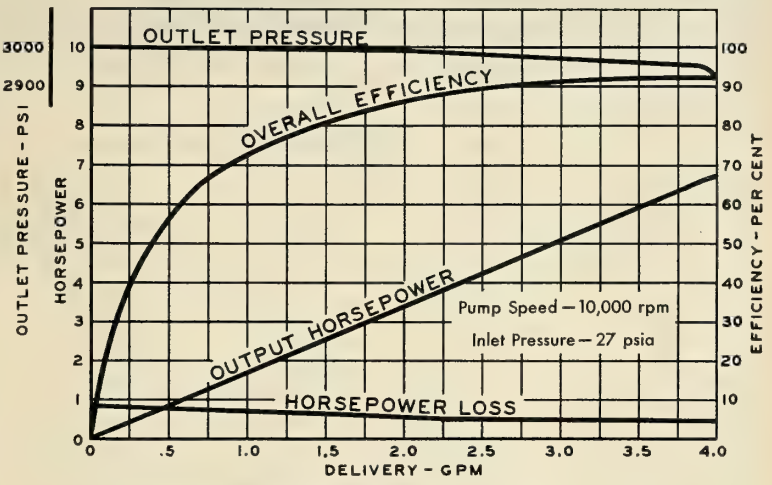


FIG. 2. Pump efficiency is shown over entire flow range.

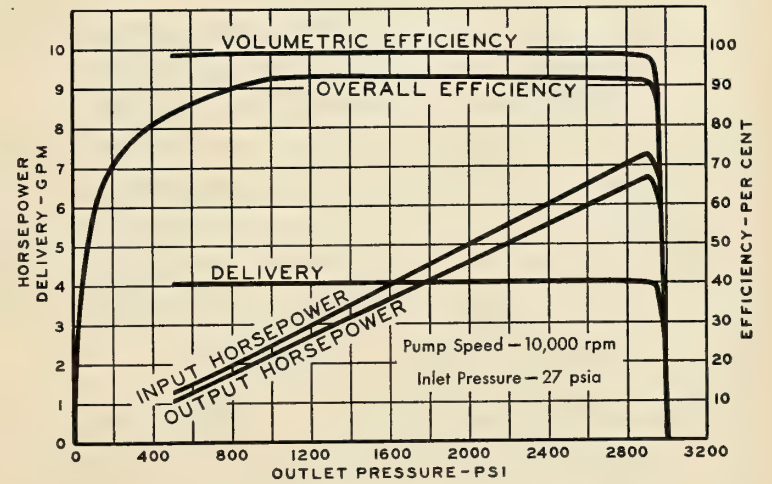


FIG. 3. Pump efficiency is charted over pressure range.

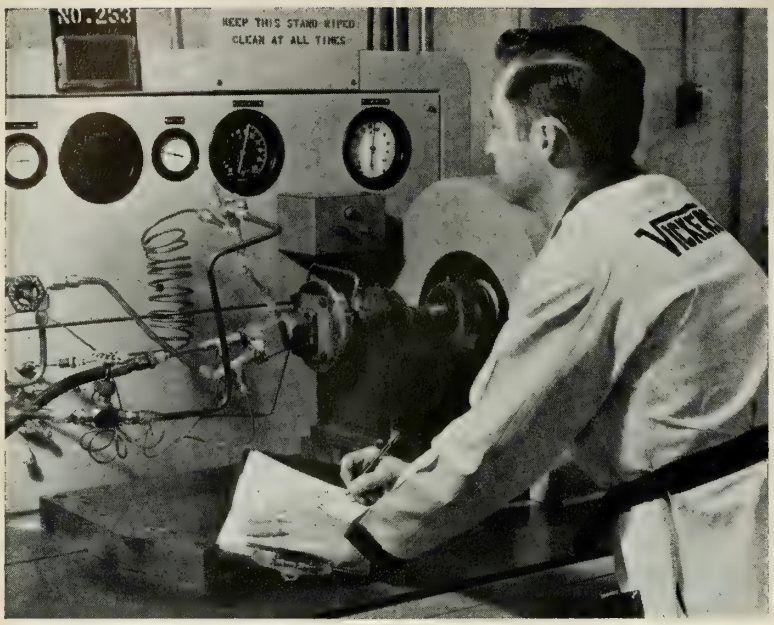


FIG. 4. Laboratory setup for endurance run of pump.

advantages apply in terms of lower electric current drain, less battery weight and longer discharge time.

• **Variable pump**—The variable displacement pump compares favorably in size with that of a standard constant displacement pump and means that variable delivery output is available from a constant displacement size package.

Development of the miniaturized variable pump actually covers several years and is the result of continuous research and engineering efforts to improve existing components.

Much of this product improvement effort was directed toward achieving optimum valve port location and shape to achieve the ultimate in pumping efficiency. Also, changing the angular position of the valve plate inlet and outlet ports with respect to piston position would vary the fluid volume delivered by the pump.

This design principle indicated that substantially fewer parts would be required and that a marked reduction in overall weight and size would result, if the reduced design would not sacrifice efficiency.

The critical need for high efficiency, low weight and size hydraulic components for missile applications prompted a concentrated attack on these problems by the company's engineering and research facilities of prime importance to the researchers was no loss of power in favor of weight.

The miniature variable displacement pump is a direct descendant of the axial piston fixed displacement design that has millions of hours of proven service dependability. The similarity extends to the rotating group of the new pump that has the same proven design for 3000 psi operation, but incorporates new features that permit much higher rotative speeds and shorter overall length.

The unit is rated at 8000 to 12,000 rpm for 1000 hour life applications; 12,000 to 18,000 rpm for missile applications; and up to 24,000 rpm for transient, overspeed and intermittent duty.

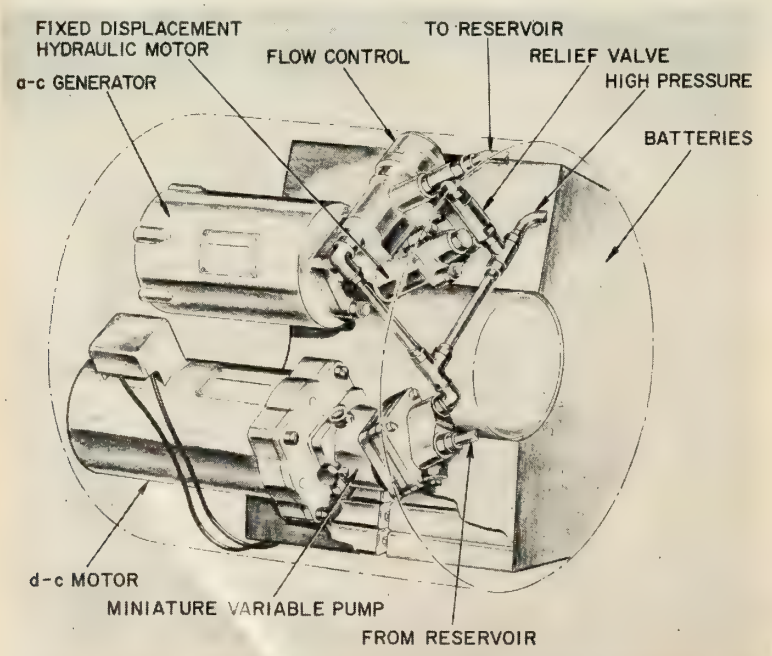


FIG. 5. Proposed auxiliary power system using new pump.

• **Characteristics**—Together with inherent reliability through simple operation of fewer moving parts, the pump possesses extremely high power-to-weight ratio (7.2 hp/lb) at 24,000 rpm and an equally impressive power-to-volume ratio (0.86 hp/cu in.) for the consideration of missile makers.

While these ratios provide an excellent means of comparing power generating and conversion devices, the real criteria for measuring pump performance is volumetric and overall efficiency.

Because variable delivery pumps are selected to conserve energy at power levels of less than full demand, pump efficiency at partial flow conditions is the real test of variable delivery pump performance.

Figure 2 is a curve that shows the pump's efficiency over the entire flow range. Note especially the high efficiencies in the low flow range as shown in the chart.

Figure 3 shows that at full delivery, volumetric efficiency remains at the 96 to 98% level over a pressure range of 500 to 3000 psi.

High efficiencies across the entire

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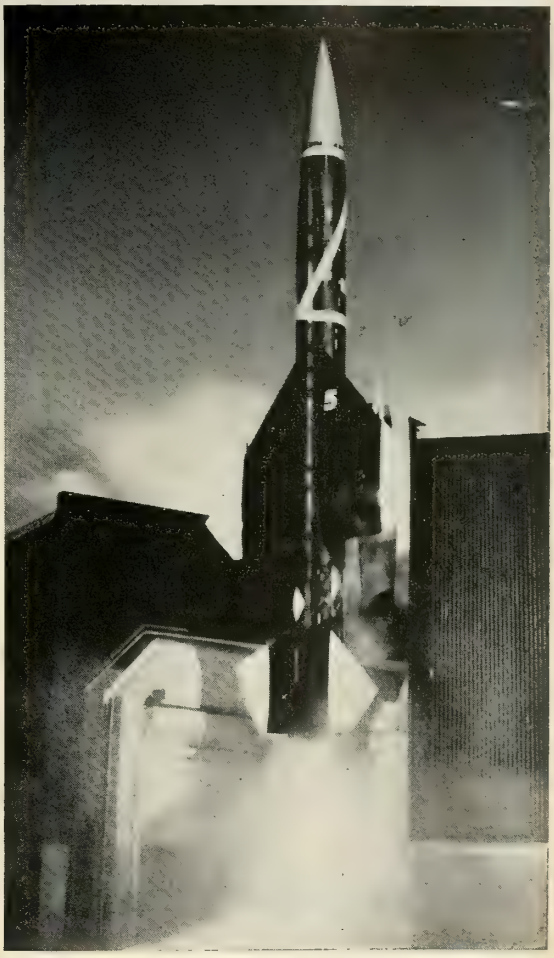
The Bomarc's tanks and wing components are made of Armco 17-7 PH Stainless Steel because it provided Boeing designers with the best combination of weight-saving strength, corrosion resistance, and good fabricating characteristics.

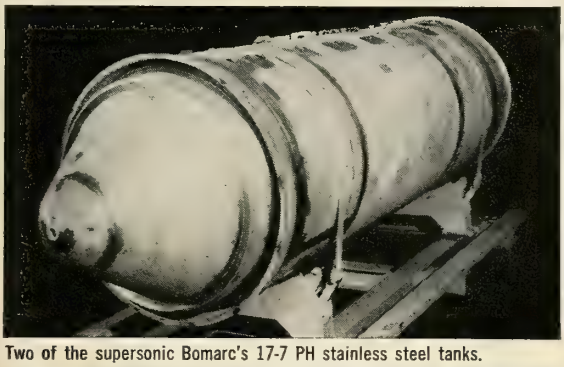
MEETS MISSILE REQUIREMENTS

For the same reasons, plus its high strength-weight ratios up to 900 F, designers of other missiles and supersonic aircraft are specifying Armco 17-7 PH for critical parts. It provides a commercially available material that withstands high stresses and heat, and can be fabricated economically by standard production methods.

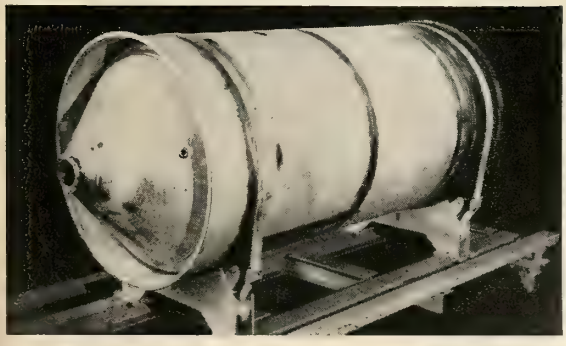
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FIG. 6. Typical motor-pump combination used in a surface-to-air flight control system.

flow range, and especially at lower flows, are significant with respect to the amount of heat rejected to the hydraulic system. Since many missiles do not utilize hydraulic system cooling, the higher pump efficiency will result in lower final systems temperatures.

Lower temperatures contribute materially to improved reliability of systems components. This heat rejection advantage is significant with respect to prime mover horsepower, reduced fuel load or longer burning time.

Missiles go through a growth period whereby second and third generation models have greater range, speed and accuracy, A hydraulic system which performed satisfactorily on a first generation missile may be marginal or inadequate to meet the operational requirements of later missiles. The heat rejection savings of the miniature variable pump promises to save a complete hydraulic system redesign on later models.

• **Rapid response** is a critical factor in missile guidance systems. The miniaturized variable pump is capable of full flow to zero flow response in 0.02 seconds and zero flow to full flow response in 0.04 seconds. The pump's proven stability immediately after a change in flow and the complete absence of pressure oscillation will provide smooth flight control operation and increased hydraulic line and fitting service reliability.

The development test program for the miniature pump involved over 2,500 hours of testing in Vickers component development laboratories.

One endurance run (shown in Figure 4) on the variable control mechanism required 1074 test hours to produce 1,000,000 cycles under full flow to zero flow delivery conditions approximately every four seconds. This and other endurance tests definitely proved the durability of the design and estab-

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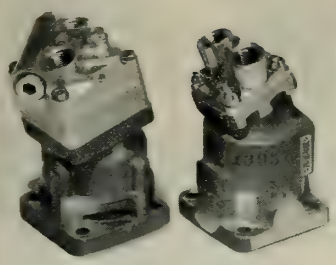


FIG. 7. Comparison of a variable displacement pump (left) with a standard constant displacement pump (right).

lished a design life for the new pump of 750 hours at 8000 rpm, 375 hours at 16,000 rpm and 50 hours at 24,000 rpm.

Currently, 24,000 rpm is considered a transient or overspeed condition, but the 50-hour design life for steady state operation appears to be attainable.

To date, all applications of the miniaturized variable pump have been for MIL-0-5606 fluid in the operating temperature range of −65° to +275°F. Other fluids can be accommodated by changing only the elastromeric seals.

• **The practical application** of the variable valving principle has resulted in a hydraulic power source of extremely low weight and small size, high efficiency, and rapid response with equal or better reliability than its predecessor.

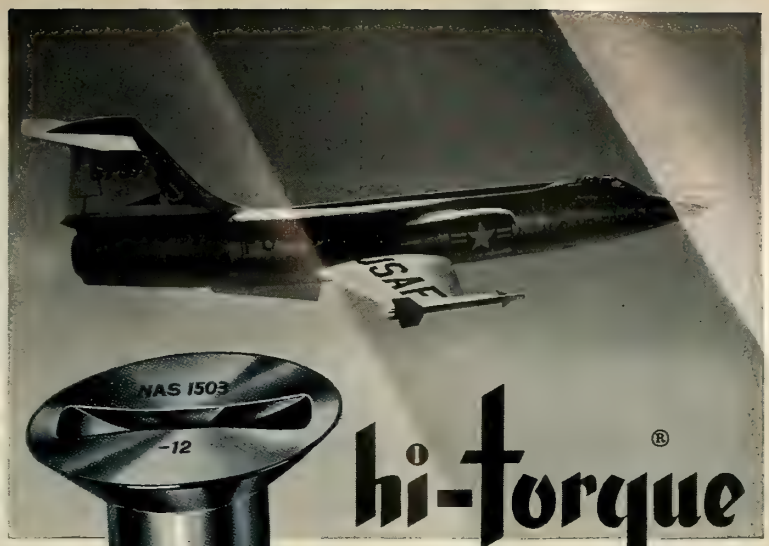
This ideal combination of features meets the present urgent requirements of missile hydraulic systems. One such requirement is a missile motorpump to power the flight controls for a surface-to-air missile. It supplies 1.8 gpm at 7300 rpm and weighs only 9.3 lbs.

Figure 5 shows the miniature variable pump used in a proposed auxiliary power system for a missile now under development. The requirements for this power system are to provide 1 kva of 400 cycle AC electrical power and a hydraulic flow of 4.74 gpm for a duration of 2.5 minutes.

The system is battery powered and in addition to the miniature variable pump, a fixed displacement constant speed motor, a 1 kva alternator, and associated circuitry and controls comprise the assembly.

Fig. 6 shows a typical motor-pump combination used in a surface-to-air flight control system.

Fig. 7 compares a variable displacement pump (left) with a standard constant displacement pump (right) and illustrates the packaging economy achieved with the new unit.



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space medicine

by Hubertus Strughold, M.D., Ph.D.

Spotlighting the growing importance of space medicine were two recent meetings—one a classified session—that brought specialists from all parts of the U.S. to listen, discuss and learn.

The public meeting was a symposium on "Simulated Atmospheres and Foreign Environments in Space Operations", conducted during the annual Washington meeting of the Aero Medical Society. Seven papers (to be published subsequently in the Journal of Aviation Medicine) gave an overall picture of human experience in such projects as Man High, Stratolab; and in submarines, space cabin simulators and pressure suits.

At this session, Dr. Siegfried Gerathewohl, of the Department of Space Medicine, School of Aviation Medicine, Randolph AFB, Texas, received the Tuttle Award for his studies on the psychophysiology of weightlessness, produced in jet airplanes. The studies were based on more than 2,000 parabolic flight maneuvers flown by Maj. Herbert D. Stallings.

The "classified" meeting—very well attended, by the way—was a two-day affair conducted by the National Advisory Committee for Aeronautics, at Cleveland. Chairman was S. P. Johnston of New York, director of IAS.

Further details have become available on the paper, "The Star Ecospheres Within a Radius of 17 Light Years from the Sun," presented by Prof. Jan Gadomski, director of the Astronomical Observatory of the University of Warsaw, Poland. This paper was on the program of last year's Barcelona meeting of the International Astronautical Federation.

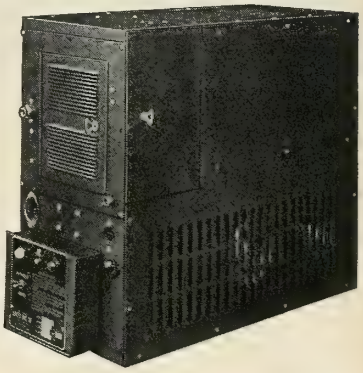
The ecosphere, as described by Prof. Gadomski at the Rome meeting of the Federation in 1956, represents a zone covering a certain distance range around the sun in which the radiation intensities and their effects upon the planetary atmospheres are such that life on planets found in this zone is conceivable. In our solar system this zone extends approximately from Venus to Mars.

Prof. Gadomski applied this concept to other stars and came to the conclusion that of the 59 stars found in this zone, about 16 might have the properties of being surrounded by an ecosphere. He concentrated in his mathematical calculations upon their extensions and placed the sun, in this respect, in fifth place.

Sirius A possesses the largest ecosphere, followed by Altair, Prokyon, and Alpha Centauri B. The next star after the sun is Alpha Centauri A. This paper represents an excellent example of the importance of the borderland between Astronomy and Biology.



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Red War Sputniks in the Works?

by Dr. Raymond L. Garthoff

AFTER THE RUSSIANS sent their first man-made moon skyward, speculation rose on how far they had progressed on a military satellite. Some Russian experts in this country claim the time for achievement of a USSR war moon is not far off.

Soviet writings on the subject have mentioned several destructive roles for such a vehicle in the event of war, from its obvious use as a reconnaissance vehicle, jamming station or rocket launcher to an Orson Wellsian instrument of annihiliation—a platform for a giant space mirror which could burn cities, cause typhoons and detonate munitions factories.

Current Russian silence on even the possibility of a military satellite suggests the existence of considerable Soviet sensitivity over the question.

It is clear from the few apparent slips in Soviet secrecy that the Soviets are well aware of the military potential of a satellite and are pushing such a program with vigor.

The military mission for an artificial earth-satellite most frequently mentioned in the West is ultrahigh-altitude strategic reconnaissance. This has been briefly mentioned in a technical article on satellites by Prof. Yuri Pobedonostov in the official Soviet Air Force journal VESTNIK FLOTA (Herald of the Air Fleet) in September, 1955.

This reference to a reconnaissance satellite was by no means the first. In a scientific journal in Leningrad in 1926, the now prominent scientist and military technologist, V. P. Glushko, had quoted an even earlier article by German Prof. G. Oberth as stating that "one can observe and photograph inaccessible countries" by means of a giant mirror mounted on a satellite vehicle.

In December 1947, NEW TIMES carried an article by M. Rubinstein ridiculing alleged American use of "Hitlerite ideas" and in particular the "fantastic" idea of a reconnaissance satellite. Again, in November 1949 in NEW TIMES, G. Tarle referred to "the madman Forrestal's idea of an earth satellite" as "an instrument of blackmail."

In July 1952, the Soviet Army newspaper RED STAR ran an article in which the late Secretary of Defense Forrestal, Dr. Werner von Braun, and Dr. Joseph Kaplan were reviled for having written about the possible military uses of satellite vehicles to "peep into other countries as through a keyhole."

Finally, just before *Sputnik* was launched last October, Maj. Gen. Pokrovsky wrote that satellites have "military significance. From them one can conduct observation of the enemy's territory." With these few exceptions, Soviet published sources are not known to have mentioned satellite reconnaissance missions.

Now, by placing their first satellite in an orbit which swept all of North America, the Soviets established a precedent which will permit reconnaissance satellites to be similarly orbited without permitting effective objections. We, on the other hand, had planned our satellite orbits to avoid the USSR in order not to alarm them or give them grounds for propaganda.

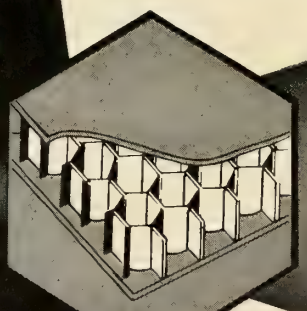
There have been reports that even the first Soviet satellite had infrared devices to map the United States for ICBM targeting purposes. Dr. Alexander Sherban, a Soviet scientist visiting in Yugoslavia last October, confirmed that some such operation was being conducted by the initial *Sputnik*.

The second possible military use of a satellite would be bombardment of targets on the earth by rockets

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Maximum System Load: (both jacks) 15,000 lbs.
Ultimate Load: 50,000 lbs. on each jack, tension or compression—100,000 lbs. total
Military Specs: Assembly designed to meet MIL-M-8609, MIL-A-8064 and MIL-E-5272A

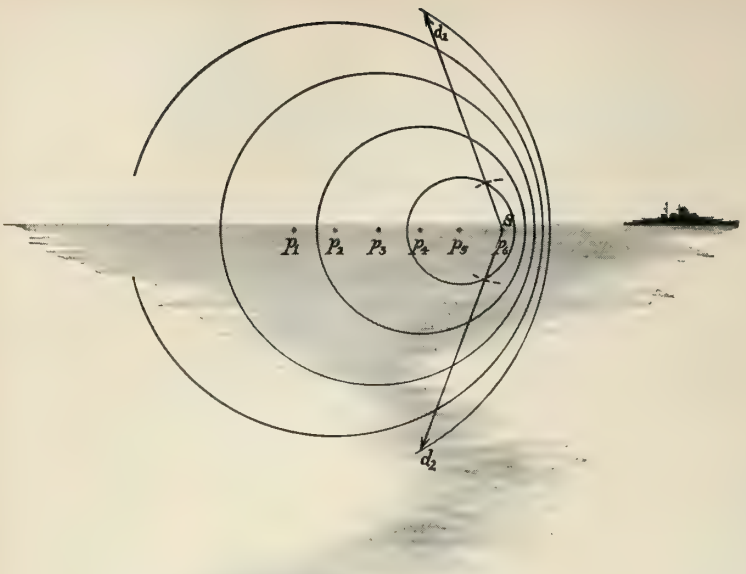
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launched from the vehicle. Again, there have been but a few references to this possibility in Soviet publications. The first was the following sentence in a book title THE STRUGGLE FOR SPEED, by the well-known Soviet engineer Boris Liapunov, published in 1952: "From a satellite one can control almost the entire planet, firing rockets at any point on the earth."

It has been charged that America was interested in using a satellite vehicle for atomic bombardment. The previously cited 1952 RED STAR article also attacked von Braun for having said such a vehicle could be used for launching missiles with atomic warheads. "Being obsessed with megalomania," said RED STAR, "they dream of the possibilities of launching from this artificial moon radar-guided missiles with atomic warheads 'against any point on the surface of the earth with fatal accuracy.' This is what the Yankees are thinking about as they dreamily look up at the shining stars."

The next reference appeared in 1954 NEW TIMES article called "Interplanetary Bunk" which said: "This is not the first time the United States is hearing ravings about 'artificial satellites' and interplanetary ships and stations from which atom bombs could be showered on parts of our planet to which Wall Street has taken a dislike. It will be recalled that a former U.S. Secretary of Defense, Forrestal, frantically urged the building of an interplanetary war base without delay."

In 1956, a Soviet military theoretician, of total war recommend thinking in advance about the employment of artificial satellites of the earth for atomic bombardment . . ." And in September, 1957, Maj. Gen. Pokrovsky referred to foreign discussions of possible military uses of a satellite as including "delivery of atomic and hydrogen bombs."

Finally, in the only case of direct Soviet admission of interest, Gen. Pokrovsky also stated shortly before *Sputnik* was launched: "The question is raised (sic) on the utilization of artificial earth satellites for delivery of atomic bombs prepared for such launching."

A third possible military use of a satellite vehicle again involves the mirror idea—the mounting on a satellite vehicle of a giant mirror to reflect and concentrate the sun's rays. Gluskko's 1926 article said: "With its aid, one can detonate munitions factories, provoke whirlwinds and storms, annihilate marching troops, burn cities, and in general wreak colossal damage."

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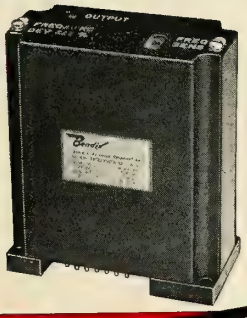
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Linearity: ±0.75%
Stability: ±1%
Input Ranges: 0 to +3, 0 to −3, 0 to +5, 0 to −5, ±2.5 VDC and ±1.5V for ±7.5% or ±15% deviation
Input Resistance: 250 K, ±5%
Output Impedance: 100 kilohms
Output Voltage: 4.0 Volts rms, open circuit
Typical Operation: Supply: 24 VDC @ 12.5 ma. Bias: 30 VDC @ 1 ma.
Size: 3.125" x 1.565" x 3.85"
Weight: 1.0 lbs.

MODEL TOR-100



STRAIN GAGE OSCILLATOR

with Silicon Transistors

These oscillators are used with variable resistance type pickups such as strain gages, thermistors, etc. with bridge resistance values of 120 or 350 ohms. The units operate over a temperature range from 0°C to +85°C and will withstand 25G vibration to 2000 cps. They are available for standard IRIG bands from 1.7 kc through 14.5 kc inclusive. Other specifications are:

Linearity: ±1.0% of bandwidth
Stability: ±2.0% of bandwidth
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Input Voltages: 70 Volts AC 360 cps to 4400 cps @ 140 and 40 MA from separate sources, or two separate 50 Volt DC sources.
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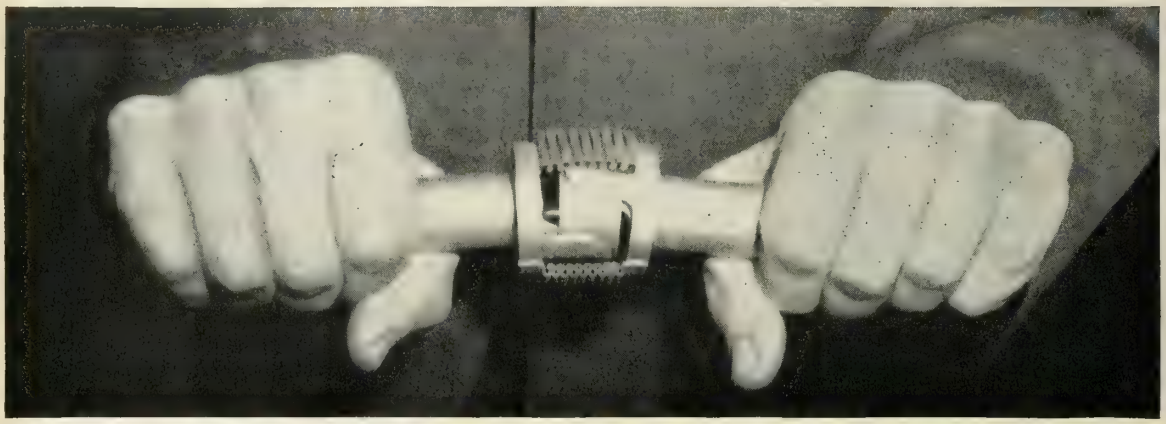
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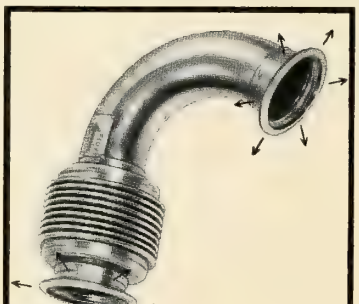
To answer a critical motion absorption problem in the most advanced jet aircraft and missiles, Flexonics engineers reached back over 500 years. They took the gimbal principle—the same one used in the compasses of Columbus, Magellan, da Gama, et al—and applied it to a flexible connector. The result is the Flexon Gimbal Joint.

Here is a joint designed especially for the supersonic space age. Its design recognizes the problems of thermal expansion, installation misalignment, air frame deflection and high end loads which are so critical in modern jet aircraft and in missiles and rockets.

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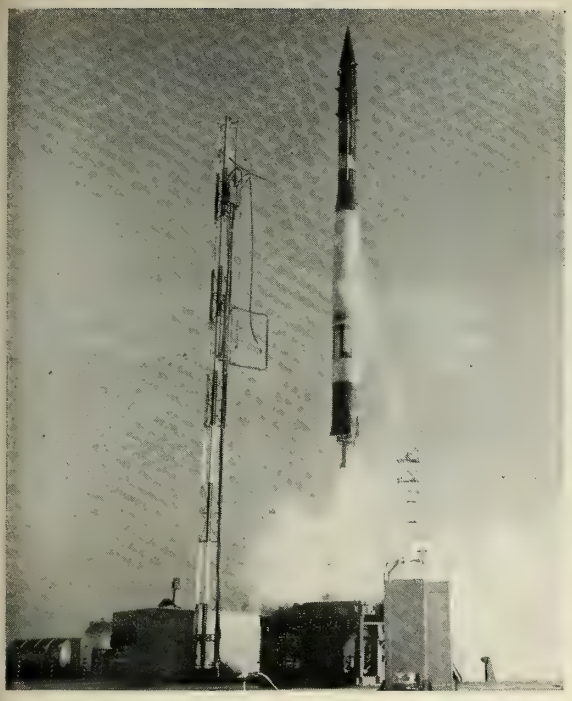
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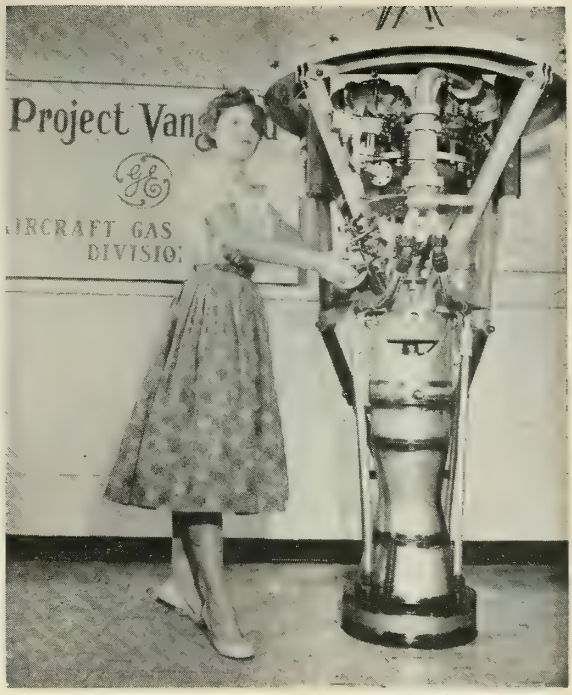
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General Electric

Power in a peanut:

General Electric's X-405 Vanguard Engine -- where it is and how it got there

by Louis Michelson*

TO ACHIEVE its specified orbit, the U.S. IGY earth satellite, launched by the *Vanguard* rocket, must attain an altitude of 300 miles and a velocity of 18,000 mph.

These requirements demand tremendous power, an examination of the *Vanguard* weight breakdown shows. Of the initial weight of more than eleven tons at launch, some nine tons are fuel and oxidizer.

Power is provided in the *Vanguard* vehicle by three stages, each driven by a separate engine. The first stage engine, built by General Electric Corp., lifts the vehicle to about 40 miles and accelerates it to 3,000 mph.

Aerojet-General Corp. supplies the second stage engine, which raises the vehicle to the satellite launch altitude of 300 miles, and accelerates it to 9,000 mph. The final velocity increment will be supplied by a solid rocket engine. Allegheny Ballistics Laboratory and Grand Central Rocket Corp. are building units for this mission.

On launching, the *Vanguard* is powered by the GE X405 engine. Providing 27,000 pounds thrust for about 140 seconds, the engine burns liquid oxygen and kerosene in its single, regeneratively-cooled thrust chamber. The propellants are supplied at high pressure to the thrust chamber by twin centrifugal pumps driven by a single impulse turbine. Power to turn the turbine is supplied by the decomposition products of concentrated hydrogen peroxide. The thrust chamber is gimballed to provide thrust vector control.

• **Birthplace**—The X405 is being built at GE's Evendale plant at Cincinnati. Here, the company has more than 6 million sq. ft. of floor space and a total investment of over $100 million.

Besides manufacturing and assembly capabilities for aircraft gas turbines and rocket engines, complete laboratory and testing facilities are maintained. A computation center, housing IBM 701 and 704 computers, provides a central source of data reduction.

Rocket engines, such as the X405, are tested at the Malta Test Station, near Schenectady, N.Y., operated for the Air Force by GE. Some 30 sites for conducting component and systems tests are maintained, along with complete administration, shop and warehouse facilities. Hydraulic, chemical and propellant laboratories provide services to the rocket engine testing activities.

The test station was constructed 12 years ago for Army Ordnance and it has been modernized continuously.

It was here that GE conducted its rocket engine and missile systems tests for the *Hermes* and *Bumper* projects. A *Bumper* missile, launched in 1949, recently held the published altitude and velocity record.

• **Evolution**—During the *Hermes* work, GE built and tested the X400 engine, forerunner of the X405. The

*Manager, Rocket Engine Section, General Electric Corp.



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X400 was overshadowed by X405, which produces more thrust and burns longer. In addition, the X405 chamber is gimballed and a hydraulic pump drive was added to the turbopump assembly equipment.

The X405 is a liquid bi-propellant engine. Liquid oxygen and kerosene are stored in the large first stage tanks, built by The Martin Co. These propellants are supplied, under a small positive head provided by helium gas pressurization, to the twin centrifugal pumps. The pumps increase the fluid pressures tremendously, providing high-pressure flow to the thrust chamber. Both pumps and the impulse turbine are combined in a single turbopump assembly mounted on pads in the main thrust structure assembly.

• **Fuel Flow**—Power to turn the impulse turbine is provided by decomposition products of hydrogen peroxide. The hydrogen peroxide is stored in a missile tank and forced to the gas generator at high-pressure by helium.

Both propellant pumps and a hydraulic power pump are driven through gears coupled to the main turbine shaft.

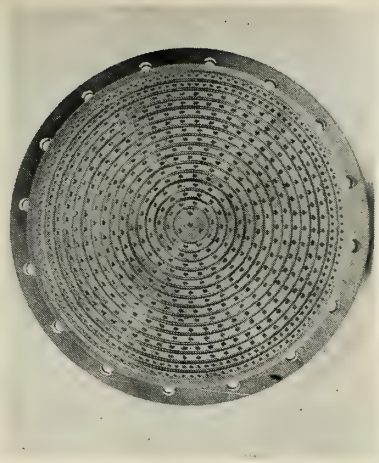
From the pumps, the main propellants flow to the thrust chamber, through a propellant control valve, through flexible lines, and into the coolant jacket of the thrust chamber.

Following this jacket, the fuel spirals upward through helical passages, through the injector, and into the combustion chamber. This provides a coolant for the combustion chamber and nozzle, regeneratively cooling the inner liner and permitting more than two minute operational cycle. The oxidizer flows from the pump through a control valve, a flexible coupling, and then directly into the oxidizer inlet of the injector.

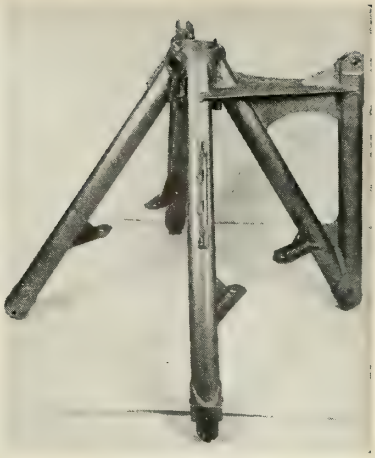
In the GE injector, distribution of oxygen is distributed from a domed area that covers the entire backplate, down through spaced slots to concentric grooves. The oxygen flows along these grooves and supplies the injector holes.

Fuel enters the injector directly from the coolant jacket, passes through radial holes and again enters the concentric grooves through a series of slots or holes.

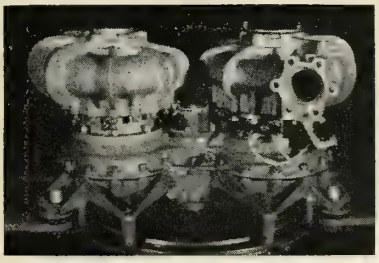
The radial fuel holes are so spaced as to pass between the axial oxygen feed slots. Particular care must be taken in design and manufacture of backplates to prevent cross-leakage within the backplate, because this almost without exception results in cata-



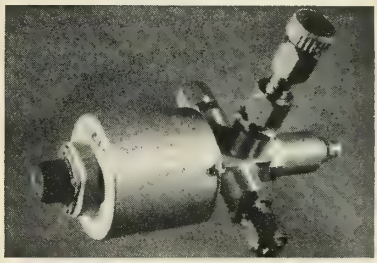
Injector head



Thrust structure



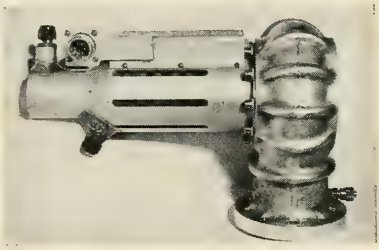
Turbopump assembly



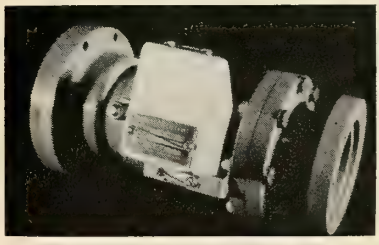
H_2O_2 control valve



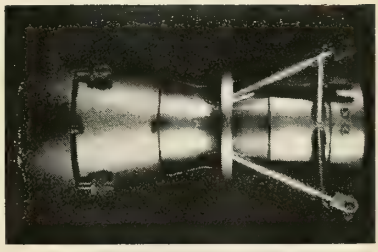
Turbine drive



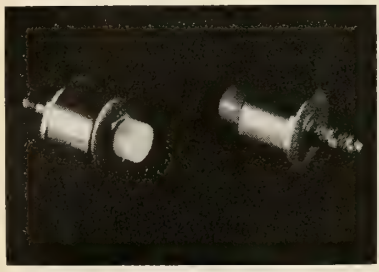
Oxidizer valve



Fuel valve



Thrust chamber assembly



Pressure switches

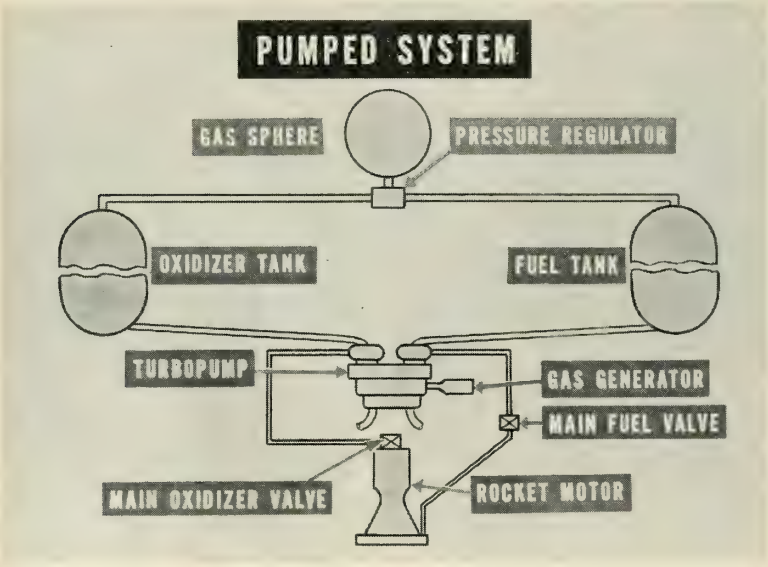


Engine control unit

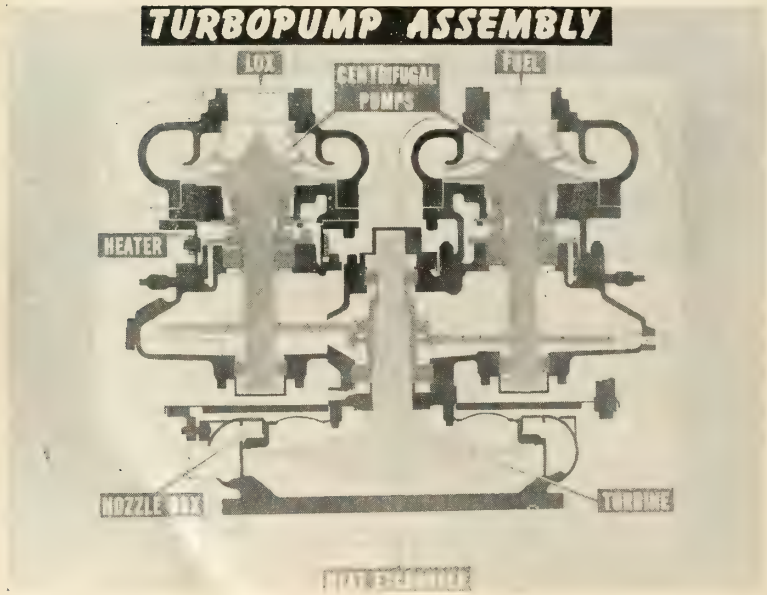
strophic failure. Obviously, total pressure drop in the backplate must be minimized and maintained at a uniform low level to supply the injector holes with a uniform pressure. Velocity within the backplate has less obvious but equally important effects on the distribution of reactant, and also should be maintained at relatively low levels. From the injector, the oxidizer is sprayed into the combustion chamber, where it combines with the fuel to provide the necessary thrust requirement.

• **Operation**—Engine operation is initiated by providing power to a pyrotechnic igniter.

When an electrical signal shows that the igniter is burning, the oxidizer control valve is opened partially and the fuel control valve is opened fully. Propellants, flowing by gravity and the small positive tank pressure, enter the combustion chamber and ignite.



Vanguard pump system and turbopump assembly.



Progress in Propulsion at Marquardt



by
Roy E. Marquardt, President

In all of the complex of modern weaponry no area affords more challenge than the field of supersonic and hypersonic propulsion. Here, where the stringent requirements for engine weight, size and thrust are creating problems of critical consequence, Marquardt engineers and scientists are making continuous progress.

The supersonic ramjets now being produced at our new Ogden, Utah, manufacturing facility provide the flight power for the Boeing Bomarc interceptor missile. Under John Winter, our chief engineer in powerplants, Marquardt engineers spent many thousand engineering manhours, to make this engine the fastest and most efficient air breathing engine in our defense arsenal.

Two Marquardt ramjet engines sustain the flight of the Bomarc after it is launched vertically into the air. The ramjets provide a range that allows the weapon to destroy enemy bombers at a far greater distance than any other missile presently in use in air defense.

The Bomarc application is only one of the many propulsion projects now underway at Marquardt. Currently under development are several advanced supersonic ramjet engines for application on future weapon systems.

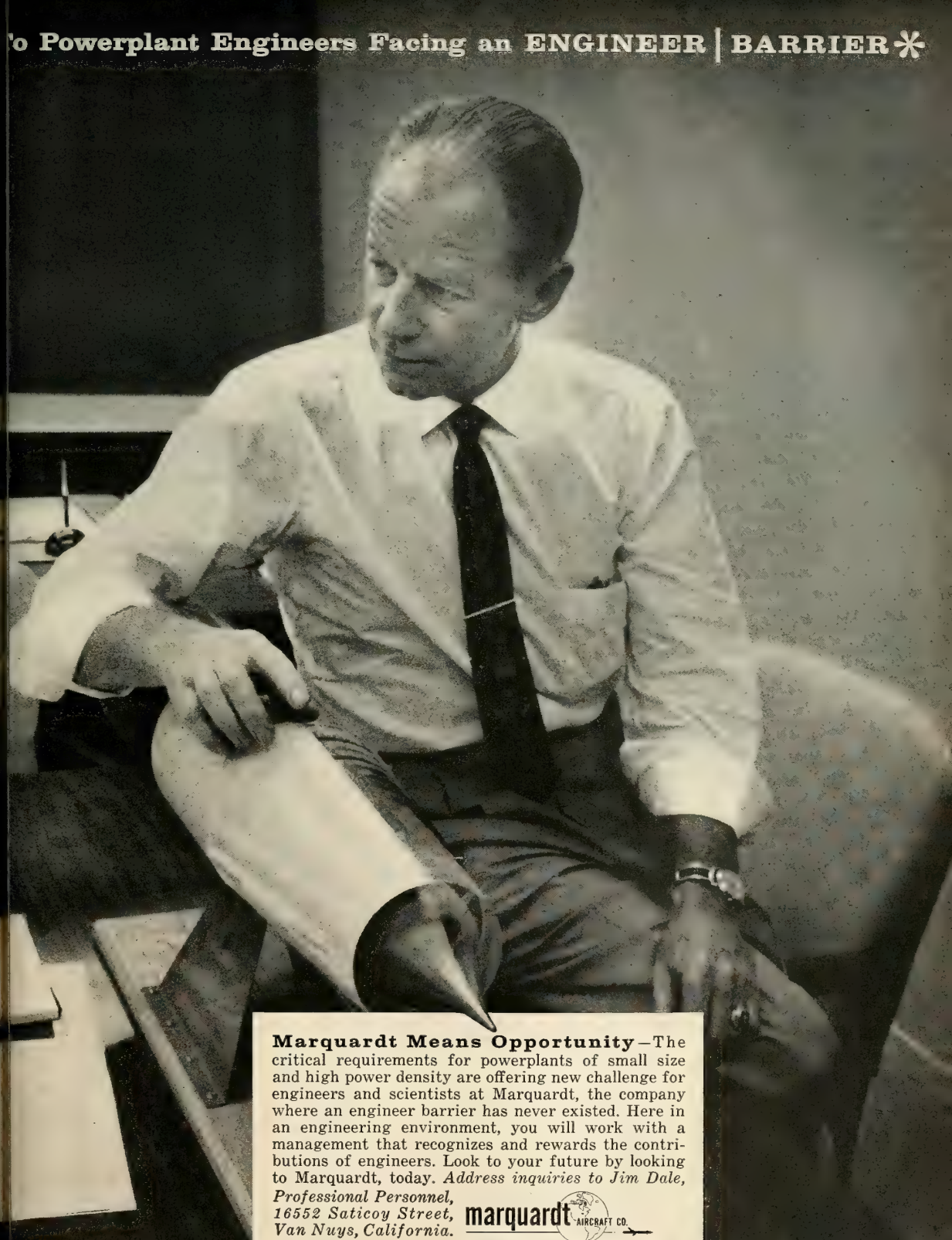
Other activities are advancing man's knowledge of hypersonic propulsion, special high energy fuels, and Aircraft Nuclear Propulsion.

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Shown here: John Winter, Chief Engineer Powerplants Sub-Division

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Since the oxidizer valve is only partially open, this low-stage combustion is comparatively low in temperature. Low-stage operation is sensed by a combustion indicator which signals the hydrogen peroxide valve to open fully. Hydrogen peroxide enters the gas generator, is decomposed into high-temperature, high-pressure steam and enters the turbine nozzlebox. The turbine starts and builds up to full speed, turning the pumps and providing high-pressure propellant flow.

The propellants then burn at high-pressures and temperatures in the combustion chamber, providing full thrust. Oxidizer flow and mixture ratio is programmed throughout the starting sequence by the spring-loaded oxidizer control valve which opens proportionately to the pump outlet pressure.

Shutdown is accomplished by signaling all three propellant control valves to close. A pneumatic delay, built into the fuel valve, prevents rapid closure and eliminates hydraulic hammer in the fuel lines.

• **Looks easy, but**—As with other conventional rocket engines, the X405 looks deceptively simple in design, construction and operation. But a brief review of the main components and their major design criteria underscores some of the problem.

Looking first at the turbopump assembly it is found that the fuel and oxidizer are fed through lines which are perpendicular to the inlet ports at the top of the assembly. The fluids then discharge through tangential outlets on the periphery of the pumps. Both pumps are driven, through gears, by a single-stage impulse turbine wheel. Both pump shafts and the turbine shaft are parallel to the engine axis.

Gears and bearings must operate at extreme speeds, lubricants must stand up over a wide-temperature range, and propellant seals must operate reliably.

As expected, development difficulties were experienced in modifying the X400 turbopump assembly for use in the *Vanguard* application. Most of these troubles were caused by the increased burning time and higher power output. The lubrication system was changed to provide more adequate cooling for several of the main bearings—as a result, the turbopump is now pregreased and operates for many cycles without component changes.

Power to turn the turbine is provided by the decomposition products of concentrated hydrogen peroxide. Stored in a separate tank, the hydrogen peroxide is forced by helium through a control valve to the turbine-drive gas generator. The hydrogen peroxide valve must be quick in response and reliable in operation. Corrosion is a major problem which can be prevented only by strict cleanliness in preparation and storage procedures.

The turbine-drive gas generator contains a silver-screen bed which acts as a catalyst on the 90% hydrogen peroxide, decomposing it into high-temperature steam. Pressure fluctuation and low-efficiency problems, encountered with early units, were solved by a screen pack redesign and insistence on extreme care and cleanliness during the assembly operation.

• **Other Solutions**—The next major components are the fuel and oxidizer control valves. Specific requirements for individual units are:

1. The oxidizer valve must provide tight shutoff as well as proportional control of flow during the start and shutdown transients. A problem with similar units is to provide sliding seals which will operate at the temperature of liquid oxygen.

2. The fuel valve must open instantly and provide tight shutoff control. Fuel must be kept from leaking into the pneumatic control sys-



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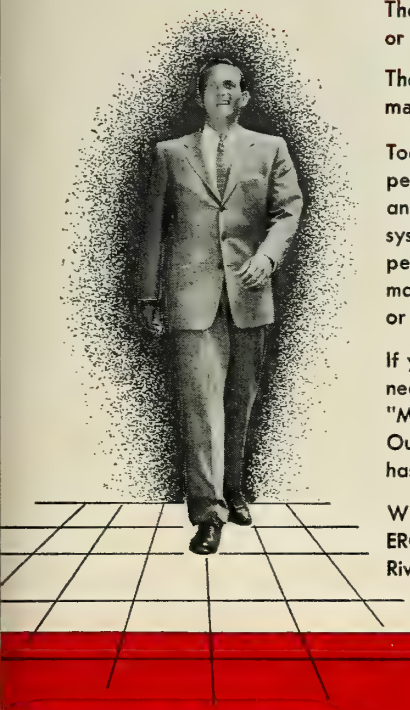
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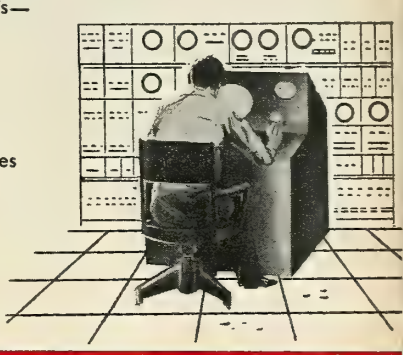
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STRAIGHT TALK TO ENGINEERS

from Donald W. Douglas, Jr.

President, Douglas Aircraft Co., Inc.

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tem. Double O-rings are necessary.

The thrust chamber assembly for the X405 gave the majority of development problems. Injector scoring and inner shell burning were encountered.

On the injector, scoring was evidenced by erosion of the individual injector rings to the point where injector characteristics were sometimes changed. Inner shell burning was characterized by local hot spots in which the metal was burned or melted to an appreciable depth. It should be noted, however, that these conditions usually did not cause static firings to be aborted.

The injector problem was solved by a careful analysis of the gas dynamics conditions, followed by a redesign of the injection pattern. Stringent quality control practices assured adherence to the design requirements. Similar steps were taken with the thrust chamber. A coolant system redesign was followed by strict quality control practices. How well these measures worked is demonstrated by thrust chamber assemblies which have operated for more than 2,100 seconds (about three times the required total operating life) without failure.

• **Thrust Structure**—The X405 thrust structure also presented problems. It had to be extremely light, yet strong enough to receive full engine thrust and provide free thrust chamber movement within a five-degree half-angle cone. Early units were modified to provide the final production item.

In addition, X405 operation depends on several vehicle-mounted and ground-based components. These are:

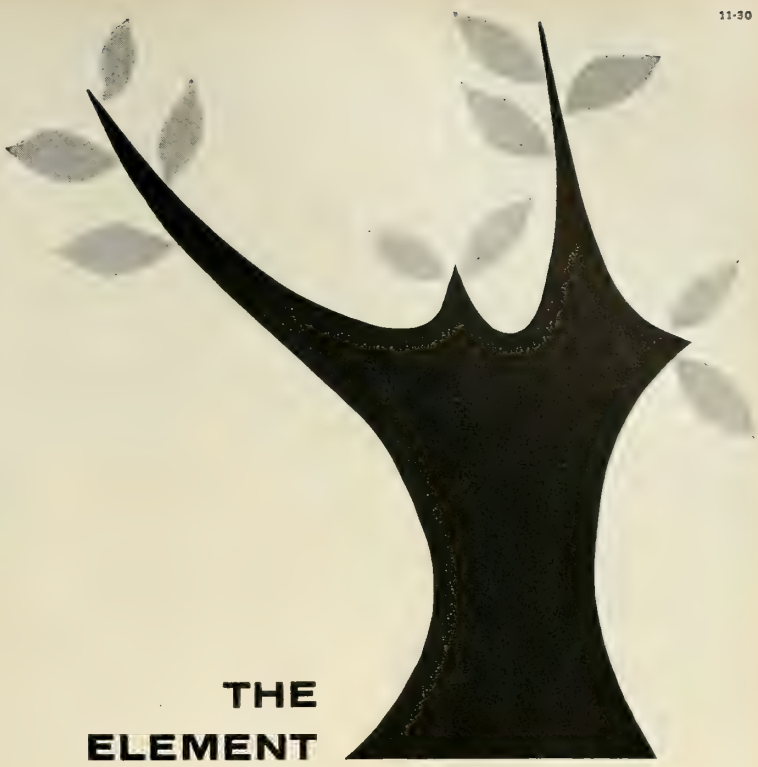
1—Pressure switches mounted on the pump outlet lines monitor pump discharge pressures and signal propellant exhaustion. This signal is relayed to the engine through the vehicle control system.

2—Engine operation during the critical ignition and starting transient stages is monitored and controlled by an engine sequencer. This unit is mounted in the blockhouse and automatically checks engine parameters, signalling the next step if valves are correct or providing for a safe shutdown in a malfunction.

3—Engine operation in flight and at shutdown is controlled by the engine control unit. Strapped to one leg of the thrust structure, this unit provides the minimum control needed in flight.

When *Vanguard* TV2 was launched, it marked the first time that a large liquid-propellant rocket was flown successfully in this country on its first attempt.

11-30



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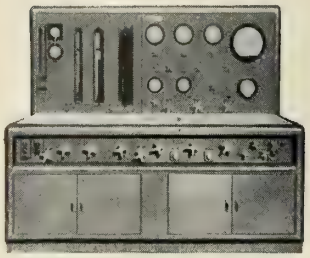
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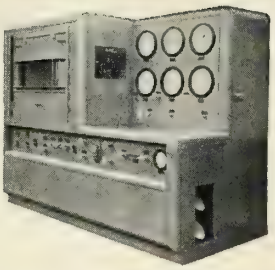
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SOME TERRITORIES OPEN FOR REPRESENTATIVES

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missile age



by Norman L. Baker

• **Bomarc funds**—Many officials working on the *Bomarc* weapons system program feel that the scheduled 5,000 *Bomarc* missile figure will never be realized, for lack of funds if for no other reason. For instance, the launchers, the lowest cost item in the system, would approach $250-million. A delivery of 5,000 *Bomarc* missiles with ground support equipment could easily require a budget of $2.5 billion.

• **Explorer III**—National Academy of Sciences scientists are hopeful that the lifetime of *Explorer* III's orbit is less than that of its batteries. In this case, the transmitters will still be functioning when the satellite re-enters the atmosphere, transmitting invaluable information on re-entry temperatures. The cosmic ray measurements by *Explorer* III is considerably more valuable than those recorded by *Vanguard* I or *Explorer* I.

• **Explorer IV** will be a double-satellite, consisting of an instrumentated payload and an inflated aluminum-foil sphere 12 feet in diameter. Due to its small mass and high reflectivity, the aluminum balloon subsatellite will enable scientists to make more accurate density measurements than can be made with present satellites. Also, plans are underway to orbit four or five 100-foot spheres for experiments in worldwide radio transmission.

• **Liquid propellants**—Die-hard advocates of liquid propellants have proposed a desperation method for keeping current IRBMs and ICBMs on "instant retaliation" standby in an effort to prolong the operational life of these weapons. Air Force officials confirm plans for a continuous fueling system devised to keep the liquid oxygen supply in "topped-off" condition. Missiles reportedly can be fired within two minutes after notification of an approaching enemy missile attack. This promises to be an excellent market for the liquid oxygen generator manufacturers.

• **Talos,** the surface-to-air ramjet missile that has at various times been under the cognizance of all the services, is, for all practical purposes, experiencing a period of suspended development. A member of the Army missile arsenal since June 1957, the *Talos* may never reach operational status. Again, lack of funds plus overlapping capabilities of sister systems (*Nike Hercules* and *Nike Zeus*) may hold further development to a minimum until other systems have forced it out of the picture. Other than the single *Talos* system at White Sands, only one other system (which is now in construction for further evaluation purposes) has been considered. This latest system will not be ready until late fall.

• **Saenger proposal**—The 30-year-old design proposal of Dr. Eugen Saenger for launching a manned globe-circling glide rocket from a rocket sled is finally receiving respectable attention in this country. The design is now reported to be in the final stages of development.

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New Formica thermo-insulator resists hot launching gases

In cooperation with Rocket Fuels Division, Phillips Petroleum Co., Formica application engineers applied a modified FF 34 with precise characteristics for protection against hot gases. The Formica laminated plastics liner protects the steel blast tube of a new target drone through a time cycle of intense heat. Formica's research and engineering staff specializes in developing new and unusual laminated plastics like this — to meet tomorrow's requirements for electronic, missile, rocket and automation equipment. There's no limit to Formica. Its great mechanical strength and heat resistance can be combined to produce the "hot strength" now so important. Formica's many other properties — flame, arc, and chemical resistance; sound and vibration dampening — are equally useful in today's electronic age.

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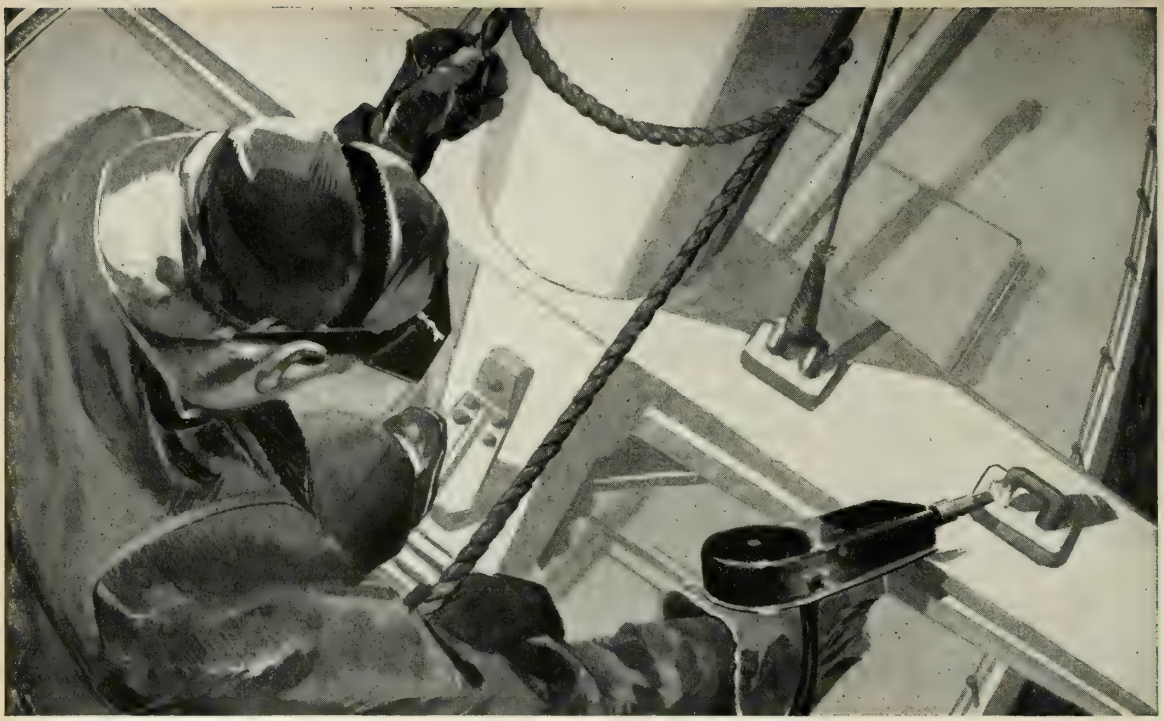
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Assess Fuel Binders for Red Rocket Propellants

Typical fuel-binders which Russia may be using with extruded ammonium nitrate propellants are synthetic rubber, polyethylene or polyvinyls, or the double-base materials such as nitroglycerin or diethylene glycol dinitrate.

The use of double-base materials blended with ammonium nitrate appears to be standard for Red artillery rockets and are probably capable of giving a specific impulse in the range 230-245 seconds. This homogeneous-heterogeneous propellant combination would have a much higher burning rate than normal straight ammonium nitrate combinations at the expense of higher combustion temperatures.

Another disadvantage appears to be a relatively high temperature sensitivity Such temperature-sensitivity is believed to be responsible for the development of field heaters as seen on the T-5B and T-5C artillery rockets.

A new extruded, high-burning-rate, ammonium-nitrate double-base propellant powers two of the USSR's operational short-range artillery rockets; T-5B and T-5C. The T-5B is a surface-to-surface missile with a range of 25 miles. It is about 31 feet long, has a launch weight of some 11,000 pounds, and carries a 4,400 pound nuclear warhead.

This missile is carried on a self-propelled launcher—a KW 85 or Joseph Stalin II AFV tank chassis. For cold weather operation, the T-5B is protected by a wrap-around clam-shell type heater.

A smaller version of the T-5B is the T-5C which may use less-temperature-sensitive propellant since its carrier has not been widely seen with a protective heater. The entire missile is smaller since it carries a warhead of 1100 pounds.

T-5C is about 25 feet long, and has a launching weight of about 4,400 pounds. The range is believed to be 15-20 miles. It is not known whether this is a scaled-down T-5B or whether advances in propulsion and warheads have allowed a drastic reduction in missile size.

The small size of the missile allows a much more mobile system than even the T-5B. Photos show that the T-5C is carried by a Type 1955 recon AFV chassis that is fully amphibious. It is significant to note that no US artillery missile of comparable size has been designed for amphibious operations.

In addition to the self-propelled features, both missiles have been designed for airlift use. The use of tank chassis carriers (in particular, the T-5C) have given them all-terrain operation. U.S. missiles are still heavily dependent on vulnerable road nets.

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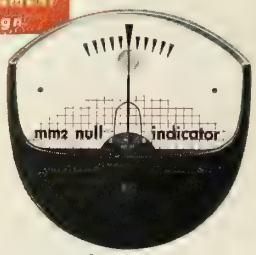
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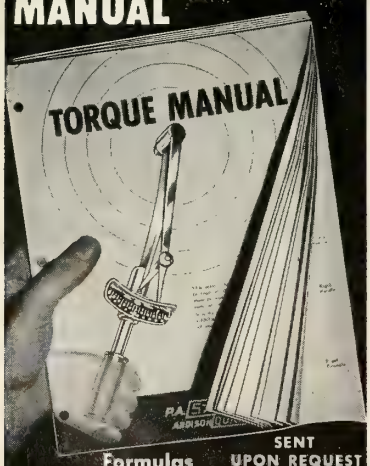
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propulsion engineering

by Alfred J. Zaehringer

Demand for fluorine in rocket propellents is low. It is estimated that the US produced 39,000 tons of HF in 1957. Most of this goes into fluorocarbons, high octane gasoline, uranium processing, and some into elemental fluorine. Best guesstimate is that about 1,000 tons of F_2 was made last year, and most of this went to AEC. About 100 tons of fluorine have been consumed by NACA, Bell, Aerojet, and Rocketdyne. Fluorine availability may take a big jump since there is now talk of producing this oxidizer directly from the gravel acid grade fluospar.

Meanwhile, NACA recently released new theoretical performance figures for the liquid hydrogen-liquid fluorine system. At 600 psia, maximum specific impulse is 381 or 392 depending on whether frozen or equilibrium composition was assumed (2740-3400 K). However, a mixture of liquid fluorine and LOX will give better performance with hydrocarbons than either 100% F_2 or O_2. This is due to the preference of fluorine for hydrogen and the carbon for oxygen.

Future for pyrophoric fuels is good, believes Gulf Research and Development Corp. about trimethyl aluminum, triethyl aluminum, and triethyl boron. Advantages for jet aircraft and ramjets are low cost at high availability, and good resistance to flameout at high altitudes. Present disadvantages are toxicity and high reactivity with water and other hydrogen containing compounds.

Boron fuel yet a trickle. A. D. Little estimates that the capacity of the Air Force (Olin Mathieson) and Navy (Callery) boron fuel plants total about 3,400 tons/year. This is only enough exotic fuel to keep a chemical bomber in the air for about 140 hours. This will limit use for extra power only (say 25% of flying time).

Ozonides for super solid oxidants? A Swiss chemical journal reports of work being done on the thermodynamics of solid ozonides such as of trans-stilbene. These ozonides may well be the next step that will push the solids into the ultra-energy class. Some ozonides are reportedly quite stable.

Polyurethanes for composite fuel-binders may be replacing the present standard polysulfide combinations. Rapid cure rate is one big drawback, says Thiokol; also the new resins offer no overall advantage over existing polysulfides. Thiokol is producing both resins. Aerojet-General is also producing polyurethanes which is believed to be going into some of their new solids. One source states that a polyurethane solid system has already been tested at an I_{sp} of over 270 seconds.

Scale-up of solid engines poses a new problem. One solid producer reports that combustion stability worsens with a given propellant as size increases. Small composition variances magnify burning characteristics in a trend from combustion to deflagration to detonation.

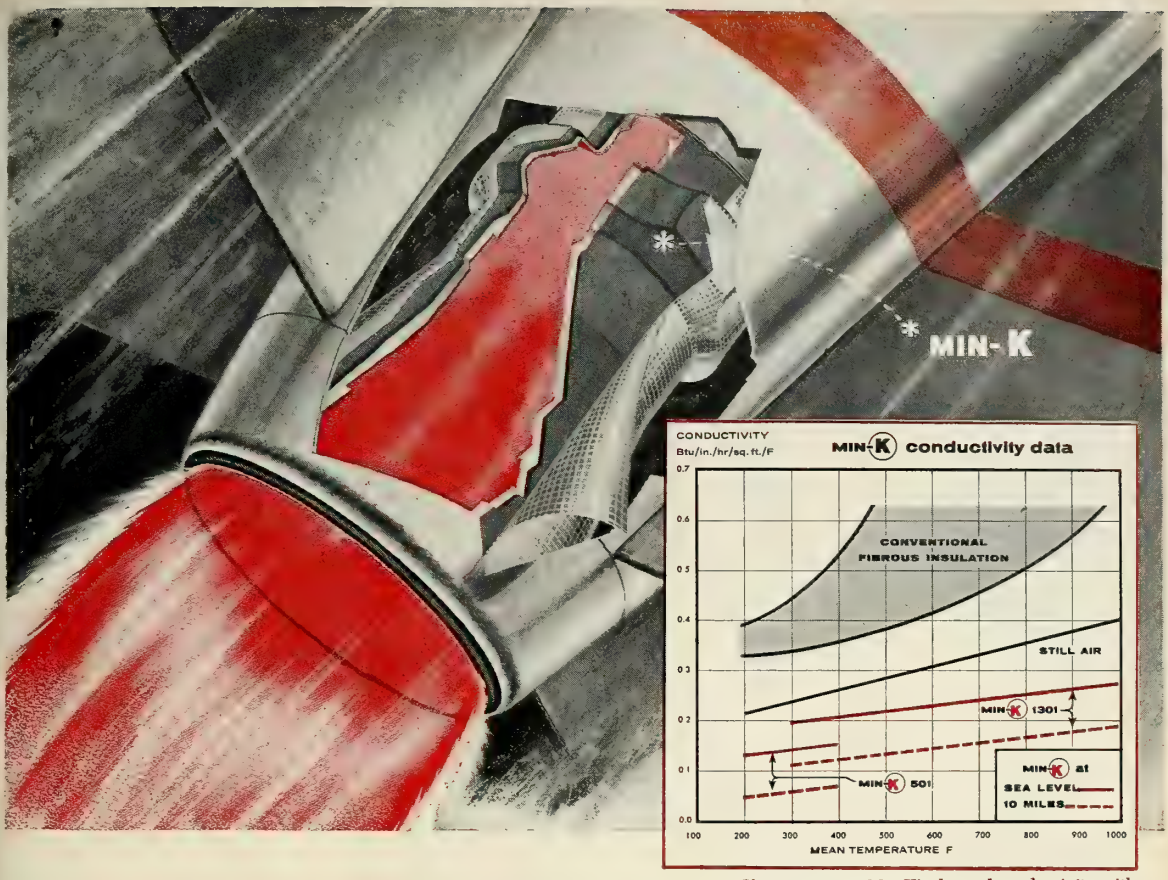


Chart compares Min-K's thermal conductivity with conventional fibrous insulations and still air. Note that Min-K's conductivity decreases with altitude.

Johns-Manville announces . . .

A scientific break-through in missile insulation!

New MIN-K has lower conductivity than still air—performs better the higher it flies

- **Saves missile space to boost fuel capacity and range**
- **Protects instrumentation more effectively to increase accuracy**
- **Offers lower thermal conductivity than any known insulating material**
- **Now performing successfully in operational U. S. missiles**

Min-K is in every meaning of the term —a scientific break-through!

For in Min-K, Johns-Manville research scientists have developed an insulating material entirely new in concept, an insulation so effective that its thermal conductivity is actually below what was long called the ultimate—the molecular conductivity of still air.

Increases accuracy and range

With this new low in thermal conductivity (less than half that of the best fibrous insulations), Min-K contributes to greater accuracy by providing more effective protection of temperature-sensitive instrumentation . . . increases range by conserving space for greater fuel storage.

Insulates better the higher it flies

Unique with Min-K is improved performance at altitude, for its thermal conductivity drops appreciably as atmospheric pressure decreases. At an altitude of 10 miles, for example, Min-K's thermal conductivity is decreased by as much as 40%, and further decreases at higher altitudes!

Manufactured by J-M as integral parts—Min-K insulations are precision molded to any shape you specify . . . encased in high-temperature metal foils or laminated to reinforced plastics. Min-K insulations include a wide variety of strengths, densities and temperature resistances.

For detailed information about Min-K, write Johns-Manville, Box 14, New York 16, N. Y. (Ask, too, for aviation insulation brochure IN-185A.) In Canada, Port Credit, Ontario.

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Alamogordo . . .

Where Missiles Bloom In The Desert

by Alfred J. Zaehringer, Norman L. Baker



Photos by US Air Force.

THE MISSILE DEVELOPMENT CENTER is situated in the Tularosa Basin of south-central New Mexico near Alamogordo. It has grown from a World War II base built for the British and used by the Army Air Corps to train bomber crews, to its present permanent status. It was here, in the Northern part of the bombing range, that the first atomic bomb was tested in 1945.

Originally named Alamogordo Air Field, the base was closed for a short period following the war. It was reactivated when the need for a guided missile range arose. A detachment from the Air Materiel Command started to prepare the new base in March, 1947.

The first rocket was launched on September 17, 1947. In 1951, the base became a part of the Air Research and Development Command. Holloman Air Development Center was organized October 10, 1952. In 1957, the name of the base was changed to the present Missile Development Center.

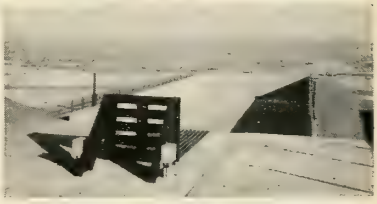
When the base was reactivated in 1947, it had a missile range of 64 miles north to south and 38 miles wide. During that time, the Army Ordnance built White Sands Proving Ground, with a range just to the south of Holloman. At first the two installations worked together, informally scheduling the greatest efficient use of the combined range—100 miles long, 40



AERIAL VIEW of new 35,000 ft. rocket test track. Breech end is adjacent to track at lower left. Track headquarters are housed at right center. White sands at left.



SUNKEN OBSERVATION blockhouse dominates rocket acceleration track's end. Booster storage is in background.



TEST STAND engine mount looking toward water pit used for cooling exhaust.



LAUNCHING AREA complex: Aerobee launch tower, control and tracking van.



THE CITY of Alamogordo, looking South toward El Paso.



PERSONNEL ENJOY winter skiing in nearby mountains.



miles wide at its greatest extent.

In 1952, the operation of the combined range formed the "Integrated White Sands Range." Use of the range is now coordinated by an Army, Navy and Air Force Committee. In the operation of the range, the Army principally provides ground support; the Air Force air support.

• **MDC in action**—In support of the ARDC mission, MDC conducts research and development of assigned guided missile systems and components; tests and evaluates missile weapons systems, missile operational techniques and associated equipment; and conducts aeromedical research and development.

At the MDC location, there are several launching complexes; a 35,000 foot rocket track; a short deceleration track; a million pound thrust test stand; an airfield, tracking stations, and other related missile equipment.

Construction has been completed on a new horizontal test stand at AFMDC. The $510,000 stand, capable of handling a million pounds of thrust, was built by the Robert E. McKee Company of El Paso, Tex.

The stand will test liquid propellant rocket sled powerplants, and for this reason, is located adjacent to the new 35,000-ft. Holloman track. The stand will also test solid units.

The facility is of open-remote construction with concreted revetments for protection—and heart of the facility is the stand. To the side of the stand is an instrumentation and observation blockhouse of direct-view type. To the rear of the stand are three propellant bays. The bay walls are constructed of reinforced concrete.

Directly in the exhaust area is a water pit for quenching the rocket

New All-Metal MARMAN

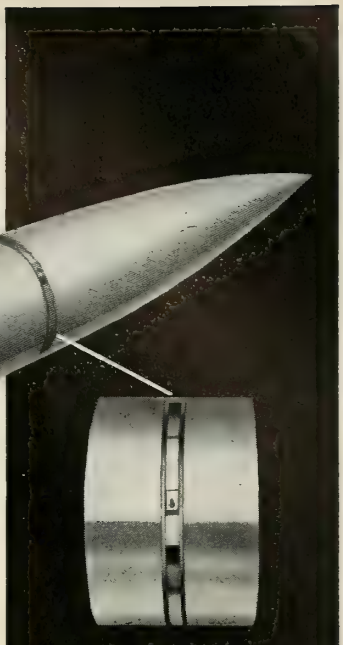
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MR-5

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H. H. "HERM" COLE, at 39, typifies one of our many young "old timers", having joined the firm in 1942, just three years after it was founded. After varied experience in airplane design, Herm was assigned to the Preliminary Design Group of the XF-88 Voodoo in 1946 upon his return from Navy service. In 1952, he was appointed Assistant Project Engineer of equipment and structures on the F-101A, later being promoted to Project Engineer. Presently, he is Project Engineer for all three versions of the Voodoo.

The headlines of our nation's newspapers proclaimed the speed of the F-101 Voodoo after "Operation Fire Wall", conducted in late 1957. Herm's entire project organization deserves special accolades since it was the F-101A model of the Voodoo which established the new world's speed record of 1207 m.p.h. for operational fighters.

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flame. In addition, the entire test pad is flooded by a water table and spray nozzles can saturate the stand itself.

At the other end of the stand, a large water supply tank and a pump house are situated. Electrically-operated pumps that can be emergency-operated on internal combustion engines, flood the stand pad and provide the fog spray.

Installation of recording instrumentation in the blockhouse will complete the facility which is scheduled to go into operation this summer.

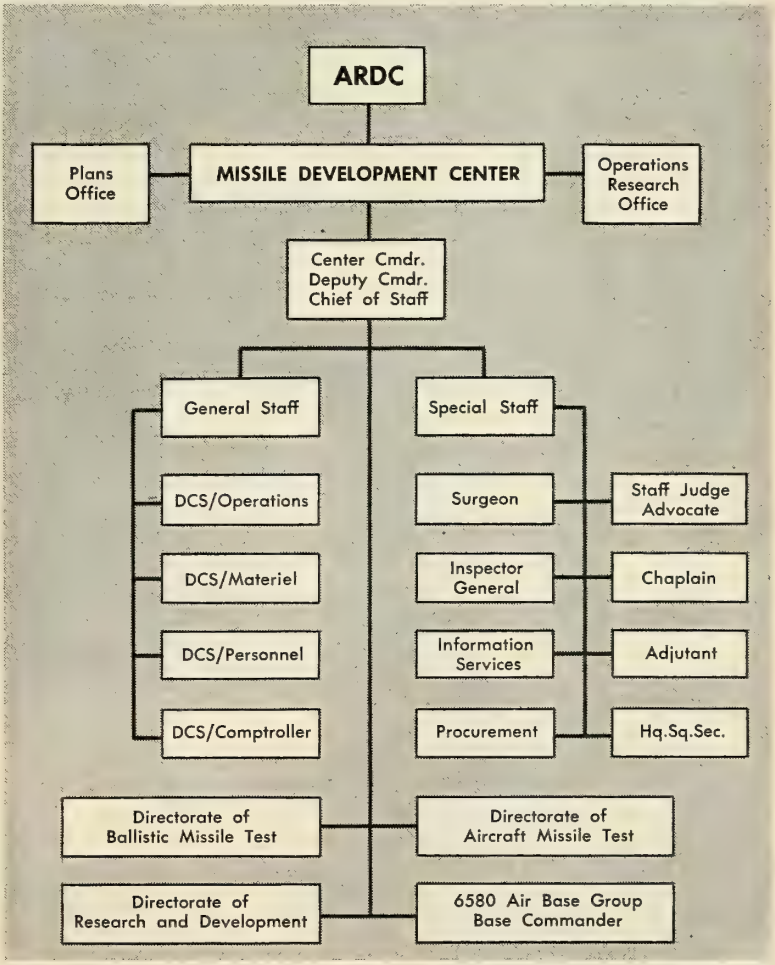
With one 50,000-lb. LOX-alcohol sled engine on hand, the stand is believed to have adequate capacity for some time to come. A closed-loop TV circuit (to be installed) will make indirect test observation possible. Data collection instruments consists of six strip-chart recorders and one 36-channel oscillograph, plus a time-sequence recorder.

Center Commander is Brig. Gen. Daniel E. Hooks. L/C R. L. Sunde is Base Commander; Col. R. E. Keating is Chief of Staff and Col. H. S. Judy is Deputy Commander.

• **Projects planned**—Current missile projects include: *Falcon, Aerobee, Matador, Firebee,* MB-1 atomic warhead rocket, *Rascal,* and the X-7 ramjet. Related work will be concerned with research balloons, ICBM activity, space biology, auto crash research, and solar furnace research.

Many units at MDC support the missile projects, including Air Force and Army tenant organizations. Some of these units are the 169th Signal Company; 3225th Drone Squadron; AACS; AF Weather Detachment 24; 9393rd TSU Detachment 3; and 9577th TSU.

Civilian contractors are Aerophysics Corp.; Bell Aircraft Corp.; Boeing Airplane Co.; Convair Aircraft Corp.; G. L. Martin Co.; Douglas Aircraft; Hughes Aircraft; Goodyear Aircraft; McDonnell Aircraft Co.; Northrop Air-





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A total of about 6,500 are employed, with an annual payroll of $35 million.

• **Climate and Geography**—Alamogordo, the nearest town, is just minutes away on a dual-lane highway. The town of Alamogordo is on the eastern edge of the Tularosa Valley—about three miles from the foothills of the Sacramento Mountains.

The Tularosa Valley is a closed basin about 35 miles wide, with the Organ and San Andres Mountains forming the western border. The valley extends northward about 50 miles.

The Sacramento Mountains on the East have a considerable effect on the climate. The mountains rise abruptly from the valley to an average elevation of 7,000 to 8,000 feet, with peaks above 12,000 feet.

Moisture-laden air from the Gulf of Mexico is stopped by the mountains, and also tends to shut out the cold winter air. This gives the valley floor a desert climate. Due to the elevation of the valley floor (about 4300 ft.), the climate is not unbearable.

The average rainfall at Alamogordo is less than 10 inches. Some 58% of the rainfall comes in the summer in brief but heavy thundershowers. Prolonged rainy spells are practically unknown. Even in the summer, there is only an average of 3 to 4 days a month when rain falls one-tenth of an inch. Fall, winter, and spring are even drier. Snow does fall during the winter, but is seldom on the ground for more than 24 hours.

	Mean Temperature (F)		Mean Precipitation
	Max.	Min.	
Jan.	55.0	28.1	0.68
Feb.	61.6	32.6	0.51
Mar.	67.8	37.6	0.40
Apr.	76.8	45.5	0.28
May	85.1	53.5	0.65
June	94.0	62.4	0.60
July	94.2	65.5	1.75
Aug.	92.7	64.2	1.48
Sept.	87.9	58.8	1.48
Oct.	77.9	48.1	0.92
Nov.	65.1	34.9	0.48
Dec.	57.4	29.3	0.50

Average sunshine is 80%, and even in the winter the sun shines 75% of the time. Typical of the desert climate, humidities are low. Relative humidity ranges from 40% to 65% during the cool morning hours, and falls to 15% to 25% in the afternoons. Winds gen-

what are your missile power problems?



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erally average about 10 miles per hour.

• **Living Conditions**—On-base housing is improving. A modern Capehart community of 400 units has been added and completion is scheduled in 1958. The current Wherry housing project is being remodeled. In-town housing compares in price to the East Coast, and is easy to buy if down-payments can be met.

Building, evidenced in the housing developments which have been completed in town during the past five years, shows permit valuation of $8,674,502 for 1956 contrasting with a value of $2,297,741 in 1954.

Schools both at AFMDC and in Alamogordo are good. The MDC base school is less than five years old; of masonry construction, and well appointed. Alamogordo has managed to keep up construction of schools and playgrounds, and there is no crowding either on base or in town.

At AFMDC, there is a medical and dental clinic, a new commissary and an Officers Club under construction. Airmen have a swimming pool; officers will complete theirs this summer. On base, there are three TV channels from El Paso. "Townies" subsist with one VHF channel.

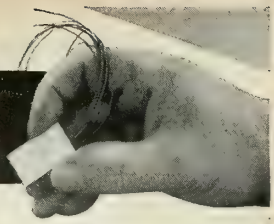
• **Area trends**—Alamogordo is the county seat of Otero County. Cotton, truck crops and feed are raised in the valley under irrigation; stock is raised on the plains and mountains. Considerable fruit is grown in the mountain valleys. The town has grown from a population of 6,700 in 1950 to over 19,000 in 1957. School enrollment is 5,500.

Lumbering is prominent in the Sacramento Mountains where several lumber camps are located. Lumber manufacturing itself places first on the list of major industries in Alamogordo in order of employment significance.

Cattle and sheep ranches dot the surrounding rangeland—the Mescalero Indian Cattle Growers Association alone averages over 2,000 head in sales each year. Much of the range land on which cattle were run in the early days has now been leased by the government for use in rocket research and artillery training.

•**Town of progress**—Alamogordo is growing at the rate of about 200 people per month. Three churches have been completed and two are in construction. The city has its share of new stores and super markets, but many people still shop by catalogue.

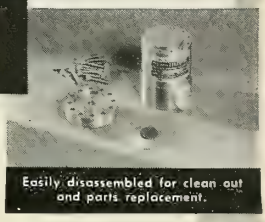
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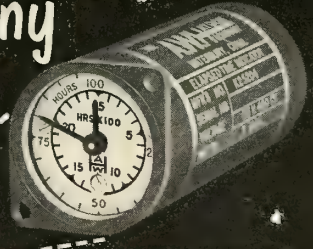
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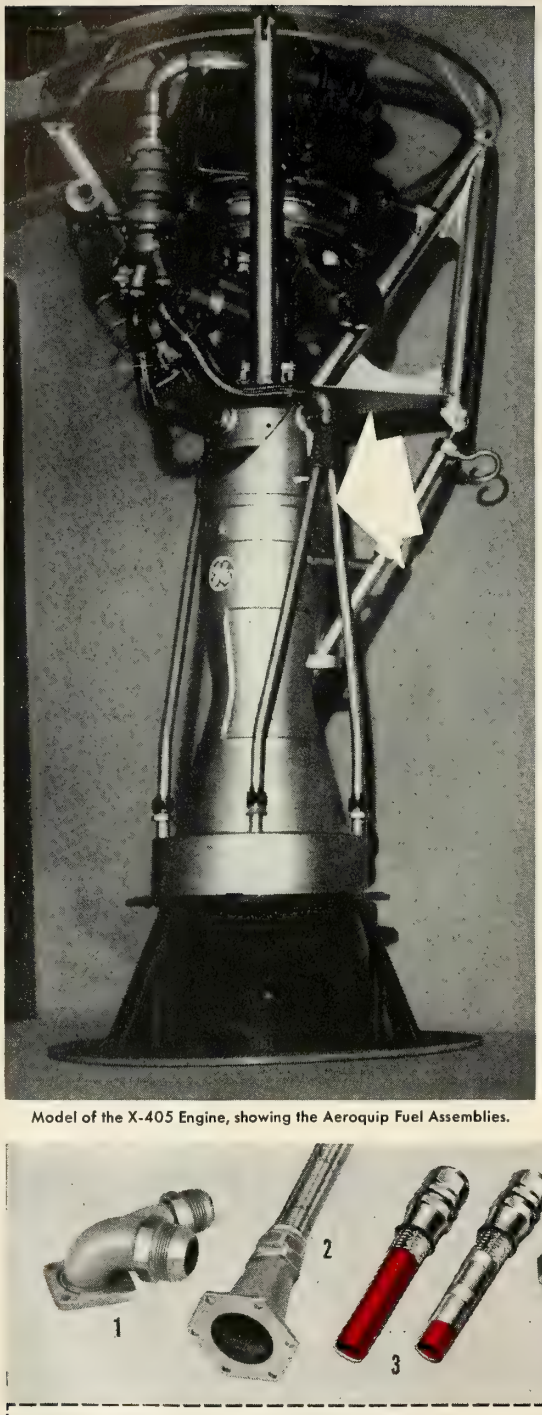
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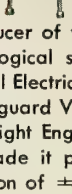


Model of the X-405 Engine, showing the Aeroquip Fuel Assemblies.

problem: design fuel manifolds to accommodate gimbal action on the first stage Vanguard engine



Aeroquip Solved it with High Performance Hose and Tube Assemblies



Aeroquip—leading producer of flexible hose lines *AND* precision tubing—was the logical source for the two fuel line assemblies on the General Electric X-405 engine that powered the first stage of the Vanguard Vehicle.

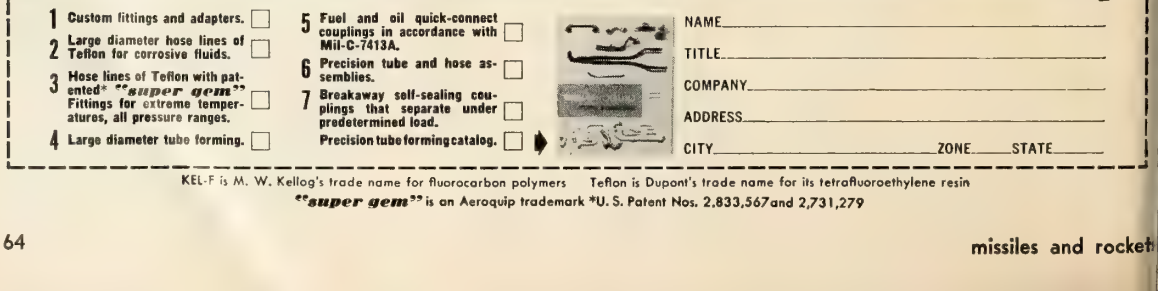
Aeroquip 601 Lightweight Engine Hose, used in connection with tube assemblies, made it possible for the fuel lines to adjust to the gimbal action of ±5° in either plane to control the vehicle's direction.

Other Aeroquip products on the Vanguard included High Pressure Hose Lines for the hydraulic system, and KEL-F Hose for the safe transfer of nitric acid during fueling.

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KEL-F is M. W. Kellog's trade name for fluorocarbon polymers Teflon is Dupont's trade name for its tetrafluoroethylene resin
"super gem" is an Aeroquip trademark *U. S. Patent Nos. 2,833,567 and 2,731,279

. . . alamogordo

Alamogordo's growth is reflected in the communications of the city, which has progressed rapidly in 1957. The telephone system of over 4,500 instruments was converted to dial on May 4. THE ALAMOGORDO DAILY NEWS, the local newspaper, went to a six-day publication on April 1. The county weekly, "The Tularosa Basin Times," went to press for the first time on March 7. A second radio station, KRAC, went on the air in June, joining KALG which is only seven years old.

Alamogordo now has 660 shops of all types, with more under construction continuously. The town offers a metropolitan life to the former big city dwellers who have come here to work in rocket research.

However, Alamogordo still maintains a small town atmosphere. It still is enough of a small town to fill the personal needs of its residents through the columns of its weekly paper.

Alamogordo is also served by excellent transportation facilities—daily service by Continental Airlines, Southern Pacific Railroad, truck lines, New Mexico Transportation Company buses, and even charter plane service. The founding fathers in 1898, and their successors, never dreamed of the rapid growth of the town which would follow the explosion of the atomic bomb.

• **Recreation**—The area is rich in recreational activities. Just five miles from the base is the White Sands National Monument with 224 square miles of pure white gypsum dunes.

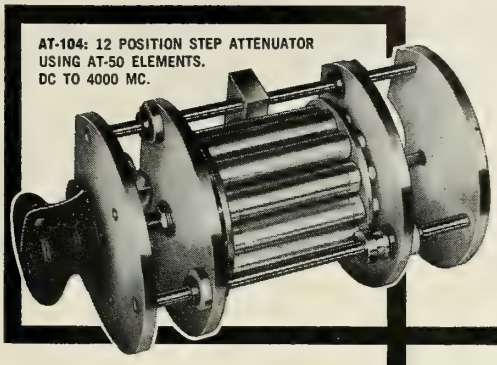
The rock enthusiast can spend hours in the various canyons in the land of the Apache, and he can also visit Dog Canyon, one of the last strongholds of the Apaches.

On State Road 83 is Cloudcroft; with a $100,000 summer resort hotel, The Lodge. The village boasts the highest golf course in America, and air conditioning by nature. Its ski run is the main attraction in winter.

Indians can be seen at the Mescalero-Apache Indian Reservation at Apache Summit; where dancing shows are put on during Puberty Rites. Also, not to be missed is the Billy the Kid pageant at Lincoln during August.

And there is always the big town of El Paso, 80 miles away. Across the bridge from El Paso is Juarez, Mexico. Juarez features bull fights; hot spots; and many shops which carry leather, jewelry, and liquors, plus gin and rum for ninety cents a quart and 120 proof vodka for $1.20 a quart. Other tourist points include Carlsbad Caverns and Big Bend Country.

WHATEVER YOUR UHF ATTENUATION NEEDS...



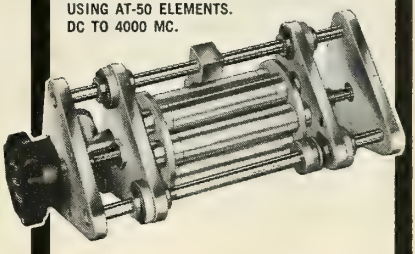
AT-104: 12 POSITION STEP ATTENUATOR USING AT-50 ELEMENTS. DC TO 4000 MC.

A COAXIAL UNIT FROM EMPIRE DEVICES WILL MEET YOUR REQUIREMENTS

Empire's UHF attenuators are resistive coaxial networks for the frequency range from DC to 4000 MC.

Accuracy is held to ±½ DB, VSWR is better than 1.2 to 1. Any attenuation values up to 60 DB are available. Deposited carbon elements are used for stability and operations at higher pulse levels. Standard impedance is 50 ohms, other values upon request. These units have excellent temperature characteristics and are vibration and shock resistant. Standard connectors are type "N", attenuator pads are also available with type "C".

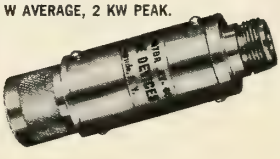
The attenuators may be obtained as individual pads (AT-50, AT-60), or as multi-position step attenuators AT-103 (six positions) and AT-104 (twelve positions). For even greater flexibility, several step attenuators may be series connected.



AT-103: 6 POSITION STEP ATTENUATOR USING AT-50 ELEMENTS. DC TO 4000 MC.



AT-50: ATTENUATOR PAD, DC TO 4000 MC. 1 W AVERAGE, 1 KW PEAK.



AT-60: ATTENUATOR PAD, DC TO 3000 MC. 2 W AVERAGE, 2 KW PEAK.

For complete technical information about attenuators for your laboratory or production needs, write for free catalog.

NEW YORK—MOunt Vernon 4-7530 • SYRACUSE—GRanite 4-7409 • PHILADELPHIA—SHerwood 7-9080 • BOSTON—TWinbrook 4-1955 • WASHINGTON, D.C.—OLiver 4-6400 • ATLANTA—CEdar 7-7801 • DETROIT—BRoadway 3-2900 • CLEVELAND—EVergreen 2-4114 • PITTSBURGH—ATlantic 1-9248 • ST. LOUIS—EVergreen 5-7728 • DAYTON—FUlton 8794 • CHICAGO—ESterbrook 9-2700 • DENVER—MAin 3-0343 • FORT WORTH—WAlnut 6-4444 • ALBUQUERQUE—ALbuquerque 5-9632 • LOS ANGELES—REpublic 2-8103 • PALO ALTO—DAvenport 3-4455 • PORTLAND—CApitol 7-3830 CANADA: STITTSVILLE, ONT.—Hazeldean 56 • EXPORT: NEW YORK—MUrray Hill 2-3760

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The manufacture of Hudson's missile wire is typified by rigid inspection and high standards. Since it is Hudson Made *All-The-Way*, from highest quality conductor rods to finished product conforming to MIL and NAS specifications, you are assured of the best.

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When you buy Teflon* wire, be sure to specify Hudson conductors. Ask our Research Department for advice on any of your wire problems.

Hudson manufactures Teflon* insulated Hook-Up wire types E and EE from A.W.G. sizes 10 to 30, in the following constructions:

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XA — Silver Plated Aluminum (47% the weight of copper)
XCW — Silver Plated Copperweld
XSP — Special Construction (to Specs.)
XR — Reinforced Core (provides a sheath of steel wires over a stranded silver plated aluminum or copper core.)

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missile miscellany

Shell Development Company is working on a fuel that will be immune to radiation, for use in A-plane's auxiliary power plant . . . Japan has fired two Kappa-150's with a .500 batting average . . . Canada will build Sparrow II . . . One of the big problems that must be solved before 1,500-mile Polaris is a fact is the successful fabrication of a 230,000 psi yield strength thin-wall, high-strength casing for the solid propellant motors . . . This page has had it reconfirmed that Thiokol "is definitely not out of the Polaris program."

Soviet Embassy officials in Washington are now peddling the line that a moon rocket is just a political stunt, that it has no scientific value—they're talking about probes shot at the moon, rather than the landing of instrumented packages on the moon. Could mean that they don't plan a moon shot before the U.S. will try it—sometime this fall . . . Army's moon rocket project's called *Juno-II*. Question. What was *Juno-I?*

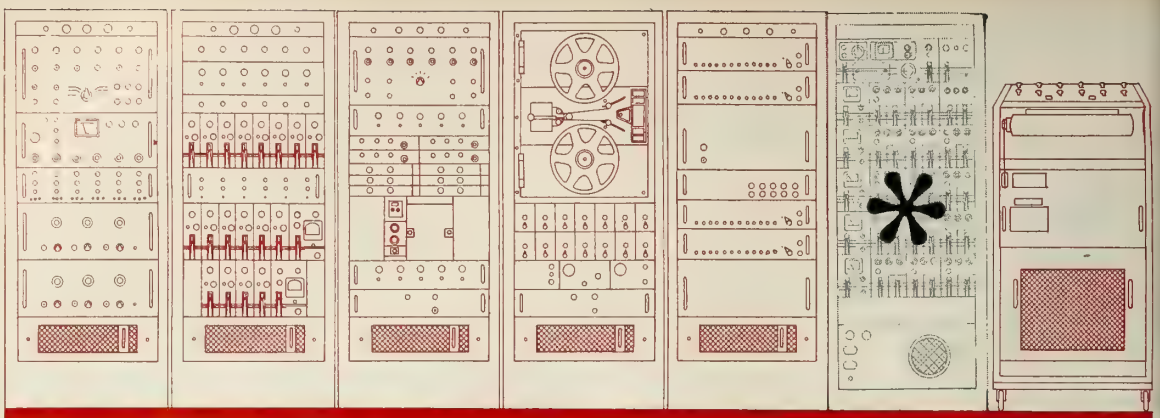
Ten Atlas missiles at their launching site will represent less than 20% of the total site cost, with 40% for ground support, 10 per cent for spare parts and 30% for technical facilities . . . If the President Eisenhower's plan for concentrating more money power in the Defense Secretary's hands goes through, look for interservice rivalry to get even more that way.

This page can't wait to see the result of a plan now afoot for unveiling a "monstrous big rocket," in which all four services participate, on Armed Forces day . . . Which is as good an excuse as any to throw one out to the Relativity experts: What happens to Einsteinian theory when you consider what you would get measuring the closing gap between two rays of light from two sources in opposition that were turned on simultaneously—twice the speed of light?

The big Pentagon fuss about m/r's story last month on Subroc turned out to be a matter of security all right—Navy League security! . . . And the other day this page happened into National Airport at a time when Wernher von Braun and John Hagen met in passing—one going and the other coming—and overheard one say as they parted: "So long, see you in orbit" . . . Speaking of missile men, Commander Bob Truax's orders returning him to Washington and the Navy's Special Projects Office have been cut and approved.

Test of Atlas guidance system is proceeding satisfactorily in an RC-121 Connie at General Electric flight test center in Schenectady . . . Meanwhile, a new and important science may be developing in what might be called "trace waves." These would be electromagnetic phenomena of a very low order of power, study of which is made possible by refinements in detection and filtering circuitry . . . At the same time, word of work on an entirely passive electromagnetic homing system for missiles, employing the Zenneck wave phenomena.

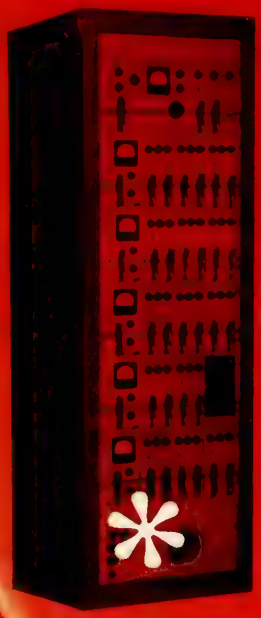
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HALLAMORE PHASE-LOCK DISCRIMINATORS

ELIMINATE SYSTEM ERRORS... AFFORD ECONOMY AND SPACE SAVING ADVANTAGES

This Hallamore developed building-block type FM instrumentation system is designed to condition and calibrate signals from any combination or multiples of the following transducers: potentiometers, flow pickup, bridge, thermocouple, or differential transformers. Hallamore manufactured elements in the system include DC amplifiers, SCO, summers, universal calibrator, calibrator test instrument, timing system and the discriminator station. Hallamore phase-lock discriminators, Model 0162, reduce subcarrier frequency information to output data, relatively undisturbed by noisy signals which contribute to the inefficiency of pulse counting type discriminators.



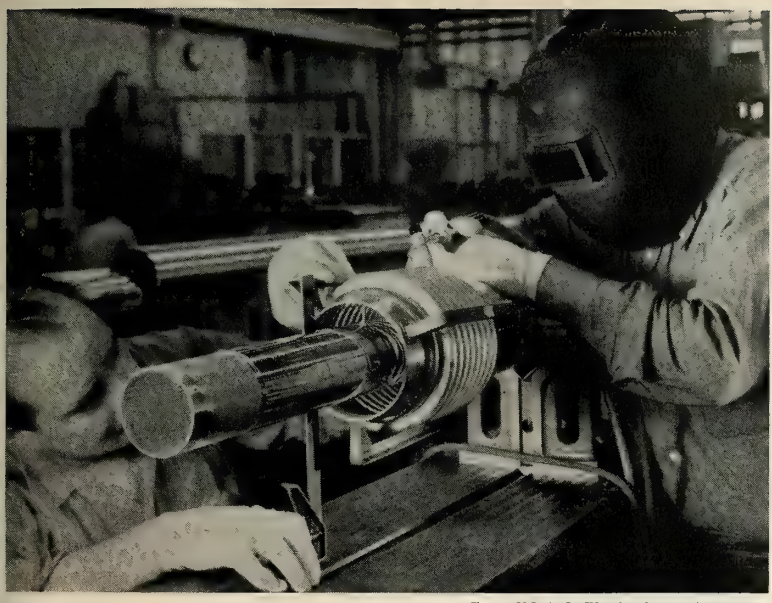
Designed around a concept entirely new to the telemetry field, the Model 0162 phase-lock discriminator eliminates signal suppression by noise, non-linearity by filtering, and thresholding at low signal-to-noise levels. In addition, the unit occupies less space, reduces overall system cost, and assists in the simplification of operational procedures. For complete specifications and operational data, write Hallamore Electronics Co., Dept. 87, 8332 Brookhurst Avenue, Anaheim, Calif.



HALLAMORE ELECTRONICS COMPANY

a division of the SIEGLER CORPORATION

Circle No. 139 on Subscriber Service Card.



Consolidated Electrodynamics Corp.

Vacuum-Jacket Lines Save Fuel

BOIL-OFF LOSSES of low-temperature liquid fuels for rockets and missiles have been virtually eliminated by using high-vacuum jacketed transfer lines.

Pipelines are being used at missile launching sites because of difficulties of scheduling truck deliveries and proper timing of unloading without creating traffic jams. Presence of trucks also creates extra hazards, and the tendency today is to fuel the rocket through a transfer line from a storage tank or generator located at a suitable distance and in an area convenient to all launching pads.

But piping is a major problem. Uninsulated lines—first used as a matter of expediency in getting rocket test facilities into operation—depend upon the coating formed by the freezing of atmospheric moisture for insulation. There is considerable boil-off, however, during the chill-down period, and in warm areas where the ice build-up is rapid, flaking-off also can be pronounced, exposing considerable areas to added boil-off.

Recently, asbestos, foamglass, cork, and glass wool have been used for insulation. They are an improvement over the natural snow coat on uninsulated lines but their efficiency is difficult to assess. However, conventional insulation requires chill-down period and large amounts of the low-temperature liquid fuel may boil away. At some stages of the chill-down process, increasing the thickness of the insulation may cause more boil-off. Condensation and resultant freezing within the insulation can destroy the insulation's thermal qualities. Use of vapor seals cause further complications.

•**New development**—Research has resulted in development of high-vacuum jacketed transfer lines by the Rochester, N. Y., Vacuum Division of Consolidated Electrodynamics Corporation.

Because heat transfer as small as 5.5 to 8 Btu/ft/hr. is possible, CEC claims that the new transfer lines can give fuel savings up to 50% over conventionally insulated lines. Even greater savings are possible over unjacketed lines.

Each section of the fuel bearing line first is treated on the outside to reduce radiant heat transfer and then is surrounded with a vacuum jacket which is pumped to a pressure of 1 x 10^{-5} mm Hg or lower. This cuts both direct and convection heat transfer.

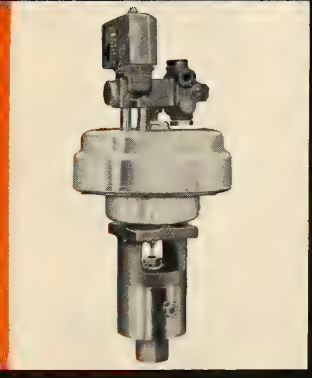
Unusual features of the vacuum-jacketed transfer lines are the bayonet-type joints providing positive leak-proof connections between sections.

The flange in the female joint has been designed so the "O" ring will be completely captured. This eliminates the nuisance of slight jarring, which might cause the "O" ring to leave the flange. All mating machined surfaces have a 63 micro-inch finish. The bayonet connection tolerances are held to 0.0005 inches, when measured on the diameter.

new ideas . . . new equipment

new 125-page catalog

SUPERPRESSURE



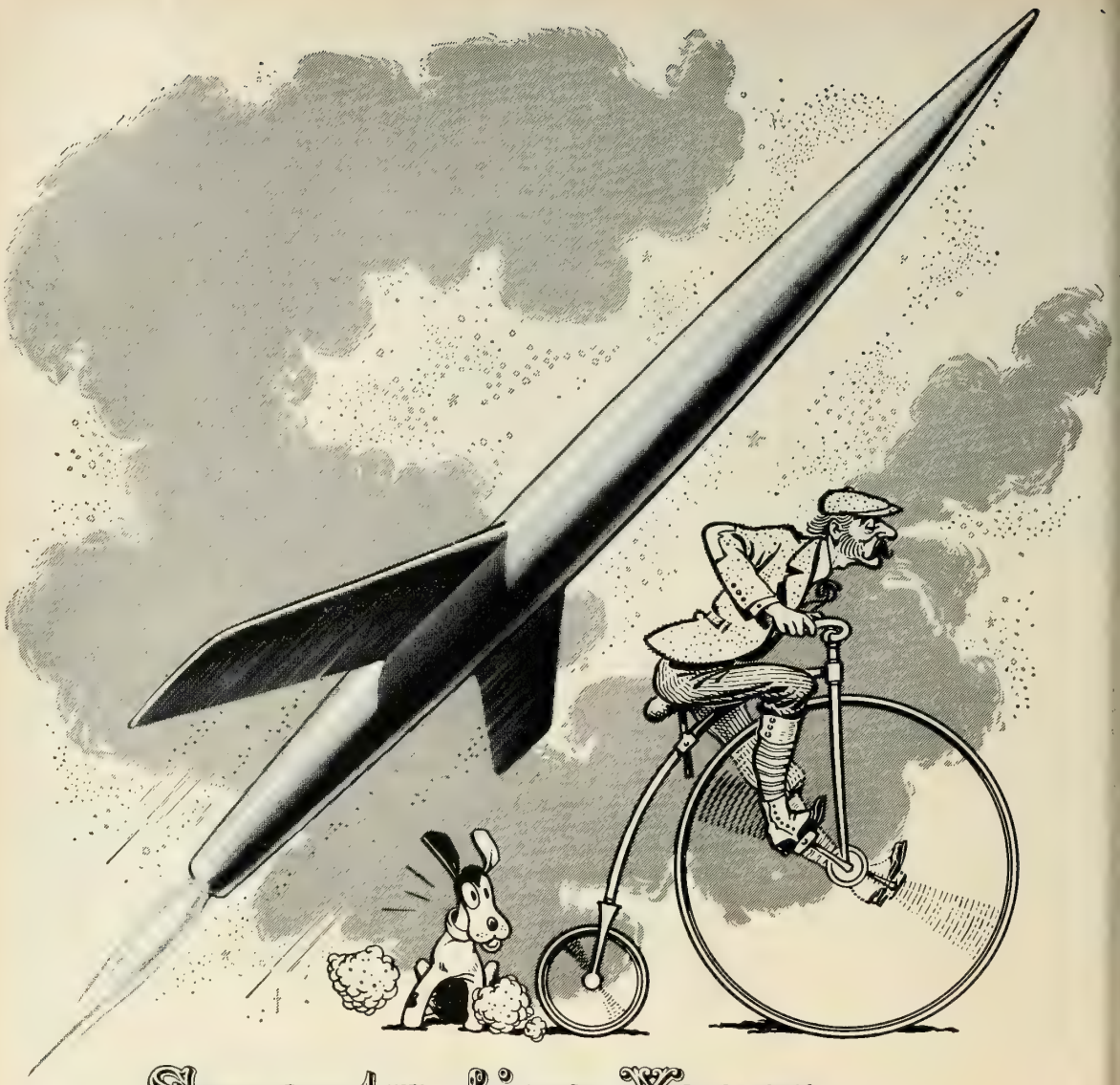
Valves . . . fittings . . . tubing . . . pumps . . . compressors . . . vessels . . . gages . . . shakers . . . quick connect and disconnect valves and fittings . . . custom built instruments . . . pressure balances . . and pilot plants are all described and illustrated in the new catalog.

The most advanced equipment available for high pressure work is described in Aminco's new Catalog 407-K-2

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TEN MILES an hour was "speed" in 1883 when Wyman-Gordon started to make forgings for the high-wheel bicycle. Through the 75 intervening years forgings have made important contributions to the phenomenal advances in propulsion. Progress from the first "horseless carriages"...from the early "flying machines"...to the supersonic speeds of today ...would not have been possible without forgings produced by the most advanced techniques of the day.

Wyman-Gordon is proud of its achievements in these fields and, as the largest producer of automotive and aircraft forgings, is prepared to accept the challenge of the future. Today, as for 75 years, there is no substitute for Wyman-Gordon quality and experience.

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world astronautics



by Frederick C. Durant III

From Great Britain comes word that their 2500 mile IRBM, the *Big Feller* (sic!), will be used to launch a satellite. This project has been reported to have "the highest priority."

A letter to The Daily Telegraph after failure of the second (fungus-bearing) *Vanguard* began: "Yeast-lovers all over the world will have been shocked at the news . . . "

From Japan, the president of the Japan Astronautical Society writes that JAS has organized 30 of the 78 Moonwatch optical tracking teams. As of February, these volunteer groups have turned in 188 observations of 1957—α (*Sputnik* I) and 299 of 1957—β (*Sputnik* II). These reports were made to the Tokyo Astronomical Observatory and radioed through U.S. Navy channels to the moonwatch center at the Smithsonian Astrophysical Observatory.

The Hot Water Jato developed at Forschungsinstitut fuer Physik der Strahlantriebe at Stuttgart has been so successful that plans are proceeding for a launcher of 440,000 lb/sec total thrust. Director of the Institute is rocket pioneer Dr. Eugen Saenger, current president of the DGRR.

Space Medical Experts exhibited irritation recently at the long lead time assigned to manned space flight by the Killian Committee. At the annual meeting of the Aero Medical Association, many privately expressed the opinion that the committee has been too conservative. Their conclusion: Space medical problems of man can be reduced to calculated risks. Cosmic radiation is no longer considered a bar to satellite flights of a few days' duration. Longer trips—perhaps. Solar flares might be a serious hazard.

They agreed that effects of prolonged weightlessness posed questions that may not be adequately answered before man is exposed. In their words, under extended periods of zero-g: (1) "Would psychological effects of apprehension, fear and anxiety affect human physiology?" (2) "Can man perform effectively after prolonged periods of sensory deprivation? Current evidence indicates a six-hour exposure under conditions of reduced sensory stimulation leads to hallucinations and possible psychotic reactions." (3) "Will muscle fiber degenerate?" (4) "Will the reflexes that control homeostasis function normally?" (5) "Could weightlessness cause panic that may lead to total incapacitation of the subject?"

Special Flights to the Ninth Congress of the International Astronautical Federation (Amsterdam 25-30 August) are being arranged by The American Rocket Society. Two departure times of these tourist fare flights are tentatively scheduled: 20 and 23 August. For details, write IAF Flight, c/o ARS, 500 Fifth Avenue, New York 36.



SOLID PROPELLANT ENGINEERS

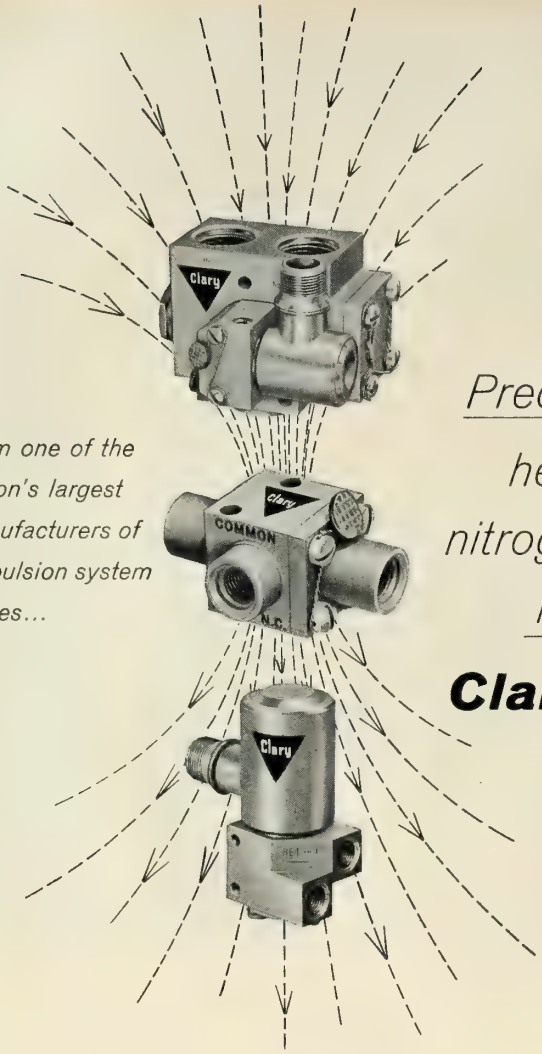
Advancements in ballistic missile and space vehicle design have opened broad new fields for solid propellant rockets. Space Technology Laboratories has challenging positions in this field for engineers with five to ten years of experience in the design and development of solid propellant rocket engines.

Inquiries regarding these positions are invited.

SPACE TECHNOLOGY LABORATORIES

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Precision control of helium, corrosive liquids, nitrogen, air, LOX...and hydrogen peroxide...with*

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Here are valves that handle all types of gases and liquids, including *hydrogen peroxide*... valves that feature zero leakage, choice of actuation, "0" ring seals, and *rated operating pressures of 4500 PSIG*... tested, proven valves ranging in tube size from ⅛" to 1½"! Here are valves engineered and manufactured by Clary – the company whose long experience, outstanding staff, and *complete facilities for extreme environmental conditions testing*, have made it one of the nation's largest manufacturers of rocket and missile valves. When precision, reliability and versatility are factors in your plans, call on Clary for complete services.

PILOT ACTUATED VALVE, 3-WAY, NORMALLY OPEN OR CLOSED
Rated Operating Pressure: 4500 PSIG.
Burst Pressure: 7500 PSIG.
Voltage: 18-30 DC.
Connector: Bendix CD 3102-12S-3P.
Leakage: Zero.
Seals: "0" rings compatible with media.
Ambient Temperature Range: –65°F to +250°F.

SHUTTLE VALVE, NON-INTERFLOW
Rated Operating Pressure: 4500 PSIG.
Shuttle Operating Pressure: 15 PSIG.
Leakage: Zero.
Ambient Temperature Range: –65°F to +160°F.

SOLENOID VALVE, 3-WAY, NORMALLY OPEN OR CLOSED
Rated Operating Pressure: 4500 PSIG.
Voltage: 18-30 DC.
Connector: Bendix CD 3102-12S-3P.
Leakage: Zero.
Ambient Temperature Range: –65°F to +160°F.

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**Under development*

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Scientists Sub For High School Teachers

Hughes Aircraft Company scientists, attending the Institute of Radio Engineers meeting in New York, subbed as guest lectures in two high schools as part of a "pilot" project to help advance scientific knowledge in secondary schools.

Lecture subjects included generation of microwaves, effects of nuclear radiation on electronics equipment, physic problems connected with automatic pilots, measuring nuclear radiation dosage absorbed by exposed personnel, and high polymer in theory and practice.

Three years ago Hughes initiated a similar program on the West Coast to bring working scientists into the classroom to show current applications of mathematics, physics and chemistry.

The project is expected to be enlarged next year with the help of IRE members from other industries.

Hughes personnel who participated are Dr. John W. Clark, manager of the Nuclear Electronics department, Physics Research Laboratory; Dr. Sam Sensiper, director of the Analysis and Circuits Wave section of Microwave Tube Department II, Electron Tube Laboratory; Dr. George Turin, research physicist; Bruce McVey, manager of the Systems Evaluation department, Airborne Systems Laboratory; Joseph Cryden, physicist and director of the Technical Information office at Hughes Aircraft Company; and Max Bart, engineer and chemist.

Careers . . .

William B. Wassell has been named standards engineer at Chandler-Evans Division of Pratt & Whitney Co. and **W. Marshall Youmans** has been appointed chief draftsman of the company. Wassell, who joined Chandler-Evans in 1950, has been senior designer of the division since 1954. You-



At Monterey, California, in tech/ops' Research Office, expansion means a need for:

Applied mathematicians and *operations analysts* with understanding of high speed computer applications for information handling; *scientists and engineers* with heavy mathematics orientation as project leaders; senior scientists with Ph. D.s, backgrounds in mathematics and physics; and *other senior scientists* in OR.

at Monterey, California

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at Washington, D.C.

At Washington, D. C., further tech/ops expansion is creating a need for:

Mathematical statisticians, Ph. D. level, with five years' experience, for research into sensitivity of stochastic games; *mathematicians*, Ph. D. level, with five years' computer experience, for OR and simulation of combat operations; and *other senior scientists* in OR.

address: Robert L. Koller
TECHNICAL OPERATIONS, INCORPORATED
Burlington, Massachusetts



FOR AIRCRAFT AND MISSILE APPLICATIONS:

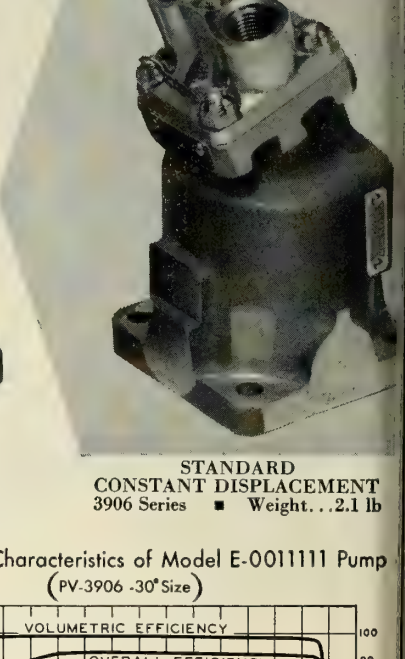
Variable Pump Design Breakthrough!

...by VICKERS

Variable hydraulic output from constant displacement package



NEW MINIATURIZED
VARIABLE DISPLACEMENT
3906 Series ■ Weight...2.4 lb



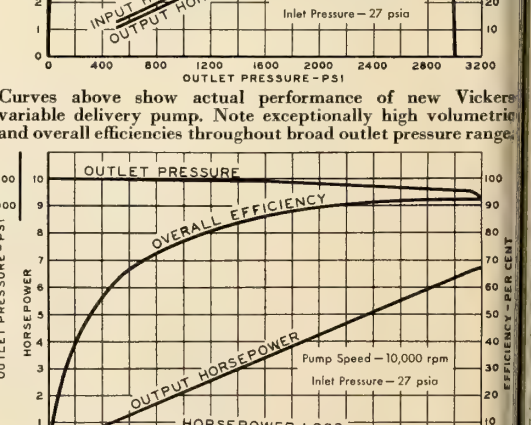
STANDARD
CONSTANT DISPLACEMENT
3906 Series ■ Weight...2.1 lb

- 48% weight reduction—70% smaller envelope*
- 12,000 rpm for aircraft applications
- 18,000 rpm for missile use
- 24,000 rpm for intermittent duty
- 9.7 gpm delivery at 24,000 rpm
- 17 hp (over 7 hp/lb) at 24,000 rpm and 3000 psi
- 98% volumetric efficiency—92% overall efficiency
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- Broad range of control methods available
- First of a new complete line
- Power saving (and heat rejection) advantages of variable displacement at fixed displacement weight and envelope.

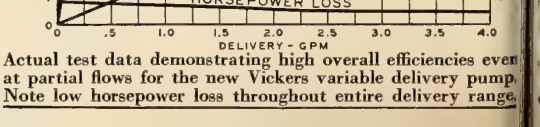
*Compared to standard 3000 psi Vickers Series PV-3906 variable displacement axial piston pump.

For further information write for Bulletin No. A-5233.

Performance Characteristics of Model E-0011111 Pump
(PV-3906 -30° Size)



Curves above show actual performance of new Vickers variable delivery pump. Note exceptionally high volumetric and overall efficiencies throughout broad outlet pressure range.



Actual test data demonstrating high overall efficiencies even at partial flows for the new Vickers variable delivery pump. Note low horsepower loss throughout entire delivery range.

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8070

. . . missile people

mans joined the company in 1955 after serving four years as a designer at Hamilton Standard in Windsor Locks, Conn.

Dr. Alfred B. Focke, physicist, has been appointed chief scientist at the U.S. Naval Missile Test Center, Point Mugu, Calif. He will be principal advisor to RAdm. **Jack P. Monroe,** commander of the center, on scientific and technical policy, professional civilian personnel and advisor to personnel of the test and evaluation facility of the Center.

James J. Kerley has been appointed manager of financial analysis for Avco's Crosley Division, Cincinnati. His most recent position was manager of forward program analysis in the controller's office of Ford's Mercury Division.

Jack M. Beauchamp has been named director of field service for the Aerojet-General Corp. Beauchamp served as regional representative and district manager of the company's Customer Relations office in New York City.

Anthony J. Krol has been appointed chief chemist of the Callery Chemical Co. of Pittsburgh. He will be situated at the company's new commercial plant at Lawrence, Kan. He formerly worked as a group leader in methods development, and coordinator for analytical matters at the company's Research and Development Division, Callery, Pa.

Alan Borch has been appointed chief engineer at the Empire Devices, Inc., Amsterdam, N.Y. He was formerly chief, magnetics engineers, of Emerson Radio and Phonograph's Government Electronics Division.

Capt. Howard Thomas Orville (ret.), former chief aerologist for the U.S. Navy, has been appointed vice president of Beckman & Whitley, Inc., San Carlos, Calif. He will assist the Instrument and Missile Products Divisions and the board of directors in long-range scientific and technical planning.

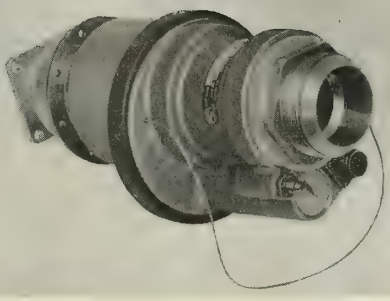
Maj. Gen. Kenneth P. Bergquist has been appointed ARDC deputy commander for Air Defense Systems Integration at Andrews AFB, Md. He was formerly assistant chief of staff, Operations, Headquarters, U.S. Air Force.

Alfred B. Rossip has been named as transistor sales manager and **Herman Bloom** as components sales manager by the General Transistor Corp. for germanium and silicon diodes, silicon medium power rectifiers and bobbinless precision wire wound resistors.

O. Franklin Frost has been named equipment sales manager for AC Spark Plug Division of General Motors to succeed **K. K. McGarvey,** who is going

ON MARK Quick Disconnect Couplings

. . . for use in aircraft, missile, and nuclear reactor fields



Another recent development from ON MARK's advanced engineering and production team is the two-inch quick-disconnect coupling shown above, Part No. 5-8021-32. These efficient remotely operated couplings are produced for aircraft, missile, and nuclear reactor applications, as well as for ground support equipment. These self-sealing couplings are designed to handle the latest ordinary and "exotic" fuels up to 800 psi operating pressure.

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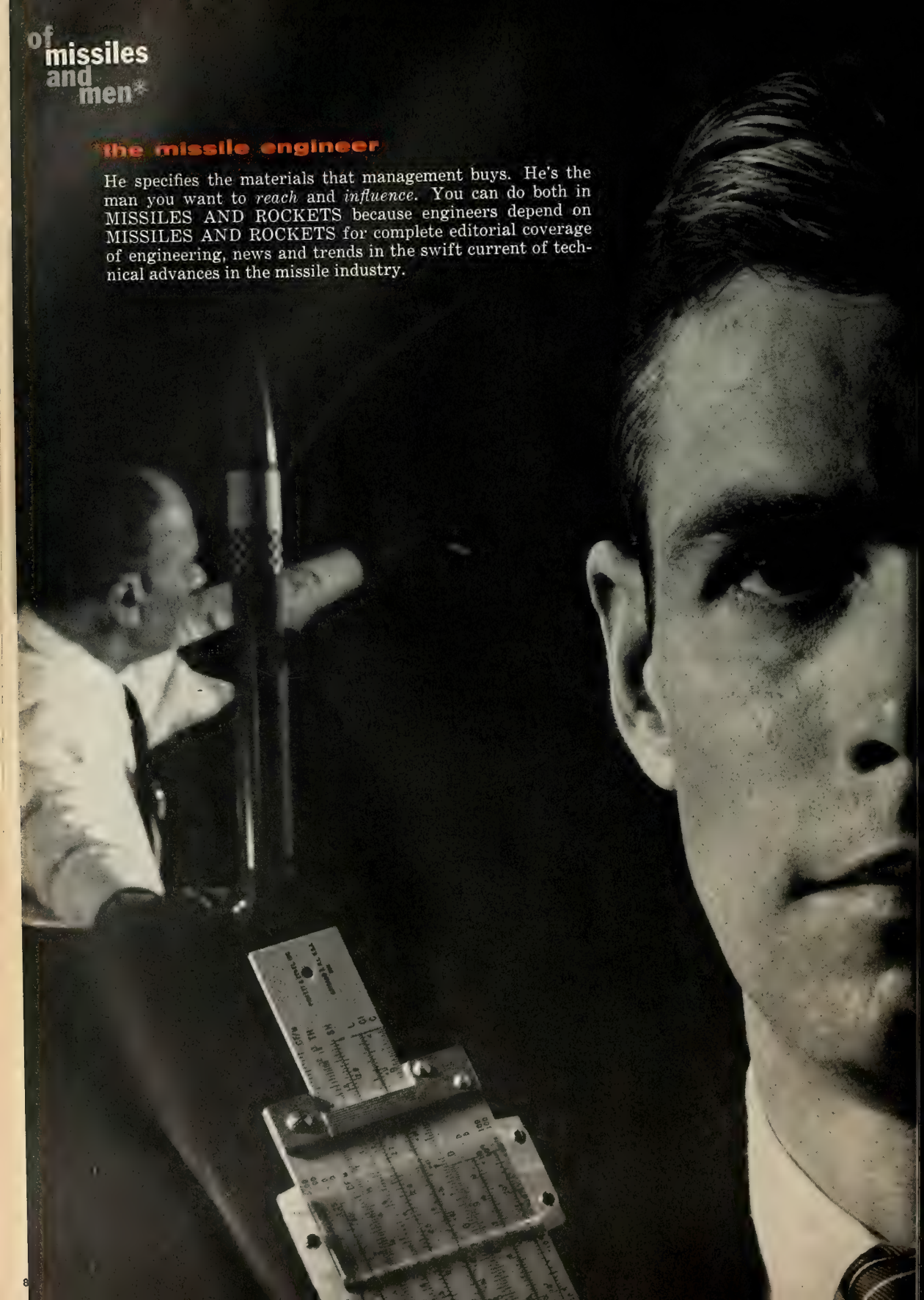
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Missile engineers look to every issue of MISSILES AND ROCKETS for vital editorial information, but the Annual Engineering Progress Issue is especially important because it contains data and progress reports that will be used for reference time and time again. In addition to the regular M/R features covering the planning, technological and business trends of the industry, the ANNUAL will give a complete summary of progress in the Army, Navy and the Air Force missile programs.

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The new authoritative Guided Missile Encyclopedia will contain complete tabulation of data with photographs and names of contractors of every missile in operation or under development in the U. S. today (as far as security regulations will permit). The addition of the Encyclopedia to the ANNUAL assures you of high readership. Last year's Encyclopedia is now in its fifth reprinting.

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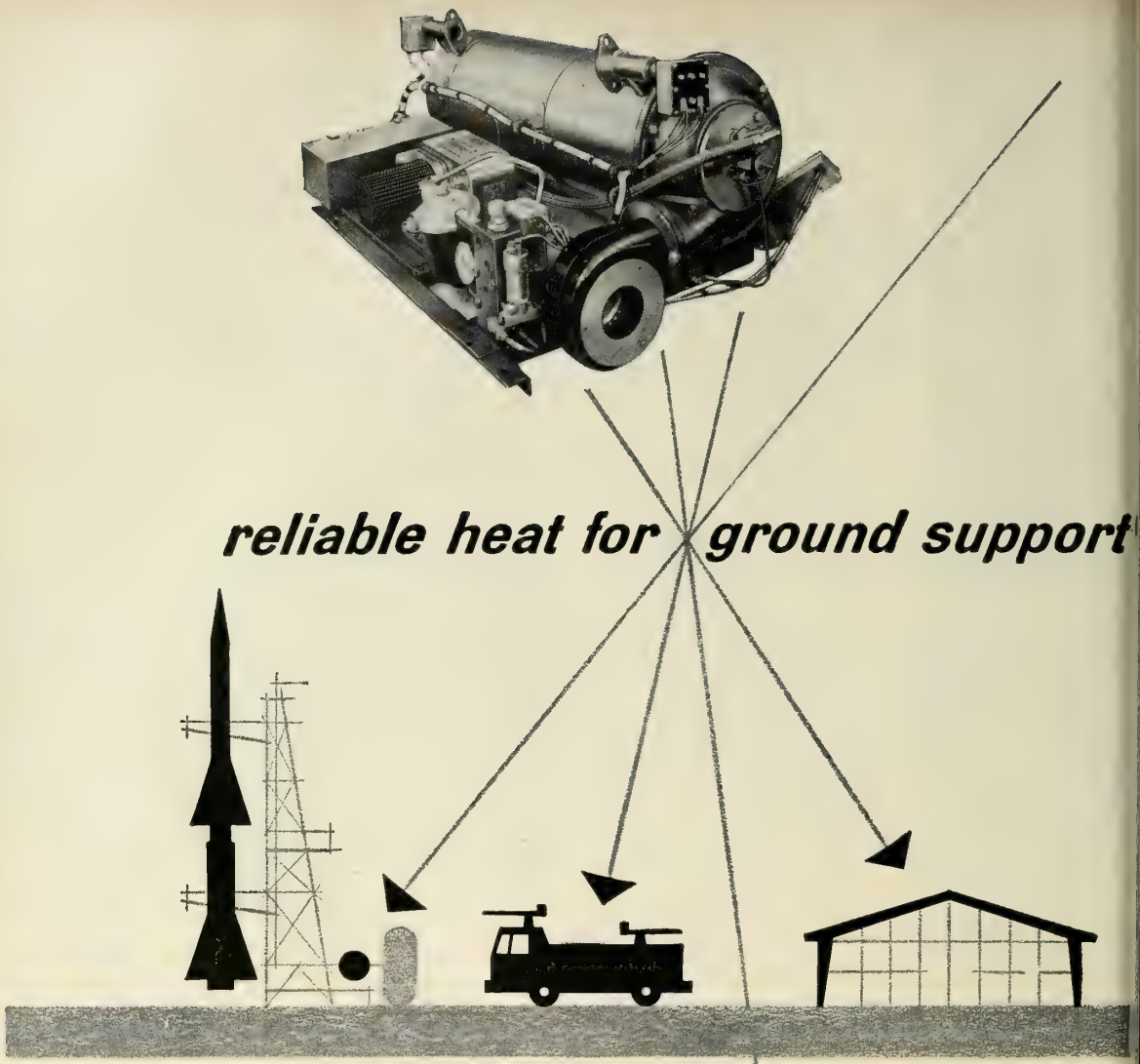
23,000 *paid* subscribers demonstrate the acceptance of M/R among missile men in this multi-billion dollar market. 431 individual advertisers since M/R began publication in October, 1956 demonstrate the wide acceptance of M/R as the number one medium to reach this market. Because of the demand of subscribers and advertisers, M/R will be published weekly starting July 7, 1958. Closing date for the July 28th Engineering Progress Issue will be July 7. Contact your nearest regional office for additional information.

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on special assignment prior to retirement in September. Frost will be in charge of sales of AC original equipment to GM car divisions and other manufacturers.

Lt. Col. Louis H. Wilson (USAF-ret.) has been named to head the newly activated Colorado Springs, Colo., office of RCA Defense Electronic Products.

Thomas I. Paganelli, manager of General Electric's missile detection systems section, has been named head of the project team that will supervise the engineering, production and installation of a super radar system which will become part of the overall Air Force Ballistic Missile Early Warning System.

John M. Welch has been appointed director of field sales for the Aluminum division of Olin Mathieson Chemical Corp. He has been Chicago regional sales manager for Olin Aluminum.

William A. Ziebell has been named plant superintendent at Chicago Aerial Industries, Inc., manufacturers of avionic and reconnaissance systems and equipment.

Kevin O'Donnell has been appointed general sales manager at Steel Improvement & Forge Co., Cleveland.

G. D. Robertson has been appointed manager of the Advanced Development Engineering Department, Government and Industrial Division of the Magnavox Co., Fort Wayne, Ind. Since joining Magnavox in 1953, he has served as staff engineer, chief sonar engineer and section chief of communications and navigation.

Wesley L. Guiles has been named manager of Flexible Tubing Corp.'s Research, Development and Test Center at Guilford, Conn.

Murray Kanes, formerly head of the electromechanical development department of the Research Laboratories Division, Bendix Aviation Corp., has been appointed director of engineering of the Friez Instrument Division. **Dr. Lloyd G. Mundie** has been appointed by the Systems Division to direct a research program in the development of infrared projects.

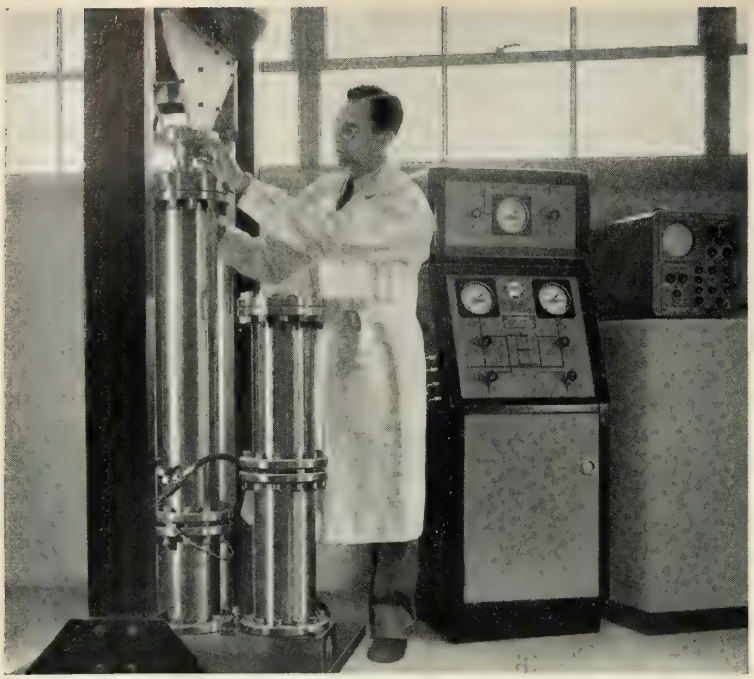
Edwin A. Speakman, former vice president and general manager of Fairchild Engine and Airplane Corp.'s Guided Missile Division, has been named to the newly-created post of manager of planning for Defense Electronic Products, Radio Corporation of America. Speakman, who served for several years as Vice Chairman of the Research and Development Board, Department of Defense, will be responsible for analyzing military requirements, planning new programs and products, and coordinating short-and long-range planning for RCA's Defense Electronic Products.

Three senior members have been added to the staff of the newly formed Electronic Systems Division of Dalmo Victor Co.: **Arthur Hartman,** production superintendent, will be responsible for all phases of manufacturing, inspection, methods and test of electronic systems, test equipment and subassemblies; **Cmdr. Irwin R. Colldeweih** (USN, Ret.), engineering coordinator, with responsibilities for military liaison and provisioning; **Roark Talley,** senior electronics engineer in the Electronic Systems Division, which currently is working in the fields of sonar, magnetic detection, communications, countermeasures and infrared.

Arthur L. Munzig, Jr. has been appointed sales manager for the Commercial Division of Librascope, Inc., subsidiary of General Precision Equipment Corp. He will direct the sales and marketing activities of the Librascope commercial electronic and mechanical computer components.



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SALES AND SERVICE OFFICES IN PRINCIPAL CITIES

Moscow briefs

• **Food For Men In Space Ships** is now being discussed by Russian experts. Soviet scientists are considering various ways and means of feeding men in hermetically sealed flying suits without opening these suits, including "possibilities of man's flight beyond the atmosphere." They are especially interested in feeding flyers from cans placed above the flyers' heads, through tubes leading from the cans to the vicinity of their mouths. Food items discussed include milk products and fruit juices, also liquefied meat having the consistency of a thick chocolate drink. Russian scientists also mention a specially prepared mixture of ham, cheese, and bread squeezed through a tube resembling a tooth-paste tube tightly fitted into the flyer's helmet.

• **A Woman Test Flyer** has recently been glamorized and publicized by the Moscow press. She is Olga Yamshchikova, a jet test pilot and graduate of the Zhukovsky Air Academy. She holds the rank of lieutenant colonel in the engineering branch of the Soviet Air Force. Formerly, a combat flyer in World War II, she has a record of shooting down several Nazi planes in battle. After the war she became a test pilot, and has to date achieved much success in this specialty. She is married and has two daughters, the elder of whom is a student of chemical engineering. Though well along in years, Lt. Col. Yamshchikova is apparently slated for a yet more spectacular service, possibly for supersonic or space flying. In this connection it may be fitting to recall that last September, at a New York symposium of the American Psychological Association, a view was expressed that the first person to fly to the moon will be not only a Russian, but a woman.

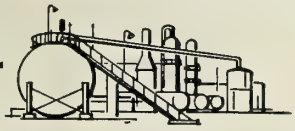
• **As A Satellite Disintegrates,** precisely what happens to it? The problem of the satellite's status in its very last phase of existence is occupying Soviet scientists. Elaborate comparisons between falling meteorites and falling artificial satellites are on the Russian experts' agenda. The more we learn about the disintegration of such satellites, say V. Krasovsky and D. Okhotsimsky in PRAVDA, the better would we be able to understand meteorite phenomena "and use the latter for additional information about the upper atmosphere."

Because the shell of *Sputnik I* was made of aluminum alloys, it could not last longer than it did, these Russian authors say. They add that in the last

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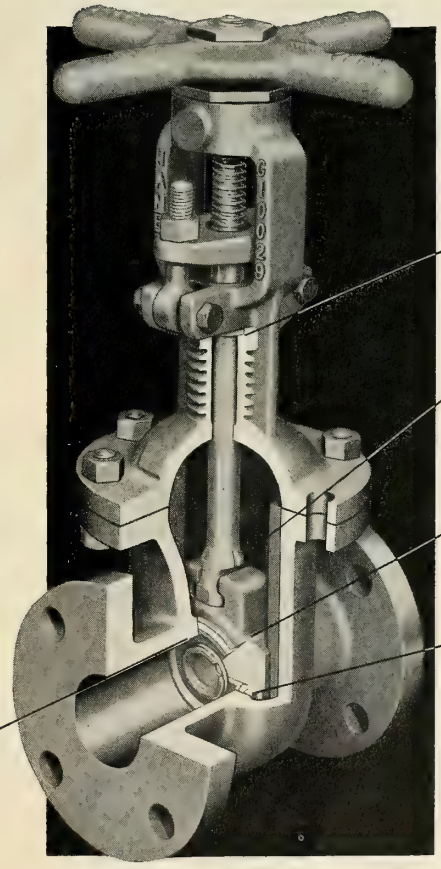


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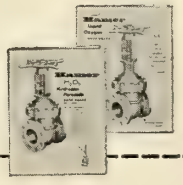
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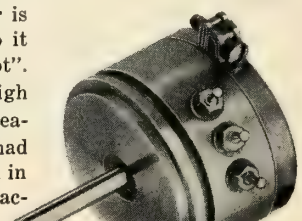
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. . . Moscow briefs

stage of its existence *Sputnik I* passed over uninhabited parts of the Earth and often could not be observed properly because of cloudy skies. "We can hope," they write, "that *Sputnik II* and other subsequent artificial satellites would prove to be more observable in the last phases of their existence."

• **A Monument** to *Sputnik I* is being planned by the Soviets. A total of 100,000 rubles (nominally $25,000) has been appropriated by the government as prizes for the best memorial projects celebrating the launching. First prize is 30,000 rubles, second 20,000, and the third 10,000. The remaining 40,000 rubles are to be used by a jury as it sees fit, to encourage other deserving contestants.

The preferred form of the monument is an obelisk, although other sculptural or architectural suggestions may also be accepted. The role of the late Soviet rocket pioneer, Constantin Tsiolkovsky, should be reflected in the winning projects, according to the rules of the contest.

The monument will be erected in front of the skyscraper building of the University of Moscow in the Lenin Hills. May 10 is the closing date for the receipt of submitted projects.

• **Visual Observation of Artificial Satellites** is done in the Soviet Union from 70 stations attached to astronomical observatories, universities, and some teachers' colleges. These are manned by nearly 3,000 regular staff members and volunteer students. The results of observations are promptly telegraphed to "Moscow, Cosmos," which is the address of the central computing office. For visual observation of satellites, the Soviets also report their recent construction of "AT-1," a wide-angled portative telescope with a sixfold magnifying power. Each of the 70 watch-stations has 30 such telescopes. The staff of the Crimean Astrophysical Observatory of the Academy of Sciences is experimenting with the addition of a photo-electric eye to their "AT-1." The eye is a photo-element connected with a precise clock, to automatically register the moment of the satellite's passing.

In Washington, Dr. Richard W. Porter, chairman of the United States Earth Satellite Panel for IGY, estimated that it would take Soviet scientists eight to twelve months to decode and analyze the data collected by the two *Sputniks*. He said that he was "reasonably confident" the Russians would share such final results with

American and other Western scientists.

Studies have been going on at Gorki's Research Institute to find the influence of gravity on crystals according to m/r sources. Values for both surface energy and potential energy within the crystal reportedly have been derived and may be expected to yield valuable data for use in rocketry such as the improved orientation of metal crystals, improved physicals in solid propellants, and possibly for gravity "windows" or shields. The USSR has already stated that it is working on gravity propulsion systems.

Nikolai N. Semenov, noted physical chemist, is reported to be heading up free radical research at the Chemical Kinetics and Free Radical Laboratory in Moscow. Semenov, awarded the Nobel Prize in 1956 for his contributions to detonations, chain reactions, and combustion kinetics, is also Director of the Institute of Chemical Physics at Moscow.

There is now direct evidence that the USSR is producing large, extruded grains of ammonium-nitrate solid propellants. In addition to the earlier extensive studies openly published on the polymorphic phase changes, the N. S. Kurnakov Institute for General and Inorganic Chemistry at Moscow has now released its studies pertaining to the extrusion of ammonium nitrate.

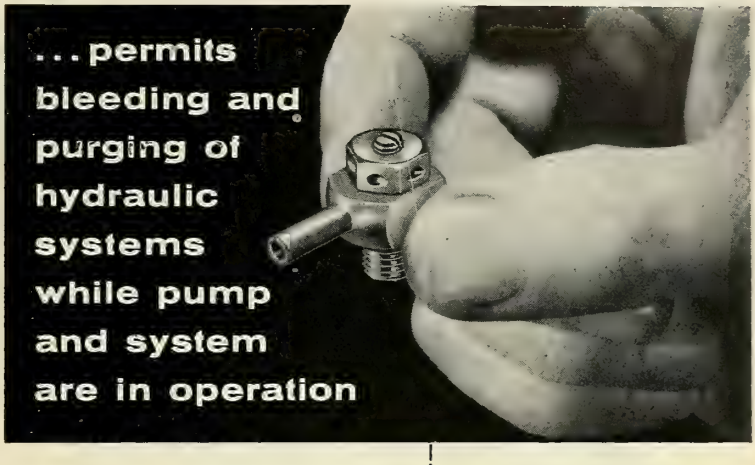
I. A. Leskovich has stated that ammonium nitrate can be transformed into a metastable state with several times the plasticity of the more stable forms. More plastic forms would allow the use of high oxidizer loadings in solid propellants (and hence higher energy) or more compact extrusion equipment.

Atoms for space flight—Latest book out of Russia's Military Publishing House (Voyenizdat) includes a chapter on the possible future use of atomic energy for interplanetary flight. Authors of UTILIZATION OF ATOMIC MOTORS are G. N. Nesterenko, A. I. Sobolev and Y. N. Sushkov.

Red eye view—An article in SOVETSKAYA AVIATSIA gave special emphasis to the U.S. missiles, *Falcon* and *Genie*. Author M. Pavlov, a lieutenant colonel in the Russian engineering troops, notes that "employment of atomic warheads in the air-to-air missiles can considerably increase the effectiveness of fighter-interceptors against enemy aircraft carrying atomic weapons."

Reds encourage "good-neighbor"

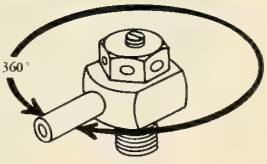
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. . . Moscow briefs

Reds—Soviet Journalist V. Ostrovsky, notes in LITERATURNAYA GAZETA that he recently flew over the island of Fernando de Noronha "where Americans have created their military base to experiment with guided missiles . . . thus attempting to violate the national sovereignty of Brazil." He expresses great satisfaction at Brazilian leftist protests against American use of the base to track missiles fired from Florida.

High-speed camera—SOVETSKAYA AVIATSIA terms "highly successful" recent Russian experiment with a camera capable of taking pictures in "millionths-parts of a second." Tests have included the recording of air bomb explosions.

Ghost Writer. KOMSOMOLS KOYE ZNAMIA, newspaper printed in central Russia, recently reversed itself on an announcement to reprint serially an old science fiction book by Alexander Beliayev. The Tambov paper said the author of THE STAR CALLED "KETS," "has decided to rewrite it; the reason being that the launching of the two *Sputnik*s and other latest achievements of Soviet science have corrected science-fiction predictions considerably." The article quoted the author as saying that he himself was going to rewrite the book. Author Beliayev died in 1952.

Writing in SOVETSKAYA ROSSIYA on the problem of returning a man to Earth from a space ship or a satellite, Prof. A. Shternfeld, well-known Russian rocket-and-missile expert, says that the use of a glider may prove to be the best means of such re-entry. He explains that a glider can be launched against the direction of orbit and can return to Earth on a slowing, semi-elliptical path.

This statement brings to mind the recently inaugurated Soviet experiments with T-4 and T-4A, rocket engines now being developed with a thrust of more than 800,000 pounds to 1 million pounds. This power is expected by the Soviets to launch a hypersonic bomber, send it to enormous heights and around the globe—then bring it back to its launching site *in a long glide.*

En route back, such a Soviet hypersonic bomber could unload nuclear-warhead bombs on practically any preselected target.

The difference between the two rocket engines is that T-4 is a test vehicle while T-4A is expected to be a vehicle in production, possibly by 1959.

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Thunder of a 1,500 mile thrust...

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soviet affairs

by Dr. Albert Parry

Our Talk of Rocketing to the Moon before the Russians could get there has of course elicited a peevish Soviet reaction. Russian air experts now charge that the Pentagon is planning "the strategy of a massive blow against the countries of the Socialist camp by using nuclear weapons from bases on the Moon." In those lunar projects Americans are "sheer lunatics," says Capt. E. Fedulayev in SOVETSKAYA AVIATSIA. But, adds the captain rather reassuringly for his readers, these American plans are being spoiled by the very fact of the existence of the Soviet ICBM which (writes Fedulayev) "plays havoc with the aggressors' deck of cards and cools off their superheated heads."

Can Earth Targets Be Hit From Moon Bases? Only a few months ago the Soviet press ridiculed this notion. But now KRASNAYA ZVEZDA declares that rockets even smaller than ICBM can hit Earth targets from lunar bases. This possibility, the Soviet Army newspaper explains, stems from the Moon's weak gravitational force, being one-sixth that of the Earth. KRASNAYA ZVEZDA therefore suggests that any East-West agreements covering control of space-warfare should include provisions on rocket bases on the Moon.

As To Moscow's Own Moon Plans, neither of the two major Red projects of flights to or around that celestial body have been publicized by the Russians recently. Professor G. Chebotarev's famous Operation Boomerang is hardly mentioned these days.

The Khlebtsevich plan of sending an unmanned "tankette-laboratory" to land on the Moon appears to be under similar wraps. This silence may mean that the Russians are preparing to spring one or both of these projects as a surprise and a mighty propaganda gain.

However, most recently, Academician Anatoly Blagonravov did say: "The very next step in astrophysical development is a rocket flight to the Moon. This perhaps is not too far off." And another Russian rocket-and-missile expert, Professor N. A. Varvarov, announced that the problem of flight to the Moon can be solved "even if chemical fuel is used."

Lunar Temperatures have recently been discussed in Moscow. The Learned Council of the Chief Astronomical Observatory at Pulkovo revealed the results of the first scientific Soviet researches into the problem of measuring the temperatures of the Moon's surface. The main report spoke of the important observations made "with the aid of thermo-elements standing in the focus of mirror-telescopes."

A large radio-telescope was also used in these researches. The sharp gap between lunar temperatures in the course of a lunar day-and-night period, as compared with Earth temperatures within our 24-hour periods, was noted by Soviet scientists. They emphasized that "the deeper the pits or craters in the lunar surface, the less sharp is this change in temperatures."

The interest with which the Russians note this last-named circumstance may lead them to plan deep burrowing into the Moon's surface if and when they reach it. Their settlements on the Moon are almost certain to be underground.



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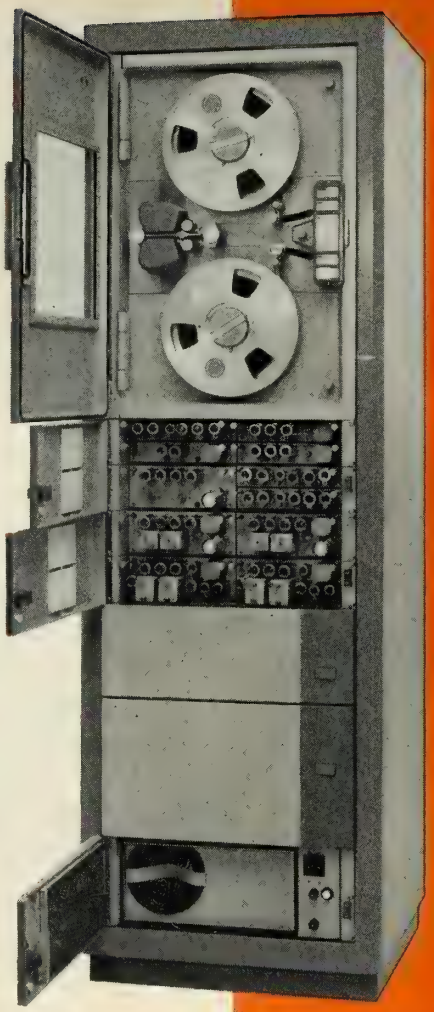
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SPACE FLIGHT AND SATELLITE VEHICLES
by R. B. Beard & A. C. Rotherham, 145 pp. $3.95, Pitman Publishing Corp., New York, Toronto, London.

The authors, who are members of the British Interplanetary Society, have assembled a kind of space primer for the "educated layman." The book encompasses recent developments and assesses imminent developments which will carry man into interplanetary flight.

Illustrated with 27 photographs and diagrams, subjects covered include basic principles of space flight, methods of achievement, our present position, proposed uses of satellite vehicles, and prospects for the immediate and far future.

The authors, through analysis of progress to date, project the space-flight question as far as 500 years ahead. Two space vehicles described as possibilities for interstellar travel by 2460 are the "deep freeze" craft and the "colony ship." The former, travelling at the speed approaching that of light, would operate automatically while the passengers' metabolism rate is slowed to the point where a journey lasting several years would age the travelers only several months.

The colony ship, moving more slowly, would accommodate a large number of people over a period covering several generations.

ROCKET POWER AND SPACE FLIGHT
by G. Harry Stine, 180 pp. $3.75, Henry Holt and Company, New York

This book might be subtitled "Rocket Power Made Easy." Using simple analogies, the author explains the basic principles of building and launching rocket and space vehicles. The book evolved in answer to the letters to the author during his five years at the White Sands Proving Ground, where he was Viking-Aerobee Project Engineer and head of the Range Operations Division of the U.S. Naval Ordnance Missile Test Facility. Material from some of Stine's rocketry and space columns, which appeared in MECHANIX ILLUSTRATED, is included in expanded form. Stine writes in a "folksy" style which now and then erupts into dialog as he dramatizes some of the rocket launchings.

The book is well illustrated with diagrams and photographs.

The book includes a world roster of rocket, interplanetary and astronautical societies; major U.S. corporations engaged in rocket research and development; colleges and universities engaged in rocket and astronautical research

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and development; and U.S. guided missile test ranges.

It is an adequate book for the beginning engineer, providing a background in rocketry that is easy and quick to digest.

BOUNDARY LAYER EFFECTS IN AERODYNAMICS
National Physical Laboratory, Middlesex, England; $12, Philosophical Library, Inc., New York

Personnel engaged in aerodynamic research will find this volume of interest. The text is a collection of papers presented at a National Physical Laboratory symposium.

The papers deal with 50-year progress in the field of aerodynamics, and with problems of boundary layer flow.

The process of transition from laminar to turbulent flow is of particular interest; also of interest is the current knowledge of shock-wave and boundary layer interaction.

Other topics include three-dimensional boundary layers; the stability of flow over swept wings; profile drag calculation of two-dimensional aerofoils for supersonic speeds; and effects of shock-induced separations of turbulent boundary layers in transonic flow.

HIGH-SPEED AERODYNAMICS
by Prof. Elie Carafoli, 710 pp. $15, Pergamon Press, Inc., New York

High-speed aerodynamic phenomena, including both subsonic and supersonic flows, is presented in this English translation of the Romanian volume, AERODINAMICA VITEZLOR MARI.

The author gives a physico-mathematical introduction to simplify the presentation and to assure a readier understanding of several transformations. The fundamental problems of the flow of compressible fluids have been studied—with special emphasis on the speed of sound in establishing equations of motion.

The one-dimensional subsonic and supersonic flows in stream-tubes and nozzles is applied to wind tunnels. The book concentrates on the study of subsonic two-dimensional flows, and flows around bodies of revolution. The supersonic flows study includes analysis of two-dimensional and axial-symmetrical motion, both in the hypothesis of small disturbances and in the application of methods to practical problems.

SATELLITES AND SPACEFLIGHT
by Eric Burgess, 159 pp. $3.95, The Macmillan Company, New York

This prolific author (ROCKET PRO-

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PULSION, FRONTIER TO SPACE and GUIDED WEAPONS) gives added evidence to his ability to write in a popular vein and still give good technical treatment to a complex subject.

Burgess traces developments in military rocketry and earth satellites, and omitting needless explanation for readership popularity, discusses future methods whereby interplanetary flight might be achieved.

The book has good illustrations, but many have been outmoded since publishing date. The author comprehensively treats the many psychological and physiological problems of manned space flight, and the book will stand as good reference material. Rapid developments may require up-dating.

SIXTH SYMPOSIUM (INTERNATIONAL) ON COMBUSTION

by The Combustion Institute, 943 pp., $28, Reinhold Publishing Corp., New York

Some 200 authors from ten nations have presented papers on developments in the combustion field dealing with chemical, kinetic, aerodynamic, and thermodynamic aspects.

This collection of papers was presented at the Sixth International Combustion symposium. Subject matter includes structure and propagation of laminar and turbulent flames; high-speed reactions; flame stabilization in fast streams; instability in combustion chambers; ignition; combustion of explosives and solid propellants; evaporation and combustion of droplets and sprays; experimental and analytical combustion techniques and applications.

The book also includes panel discussions on future problems in research, high-speed reactions and flame stabilization in fast streams.

MATHEMATICS FOR SCIENCE AND ENGINEERING

by Philip L. Alger, 360 pp. $5.50, McGraw-Hill Book Company, Inc., New York

In this text, the author makes a complete revision of Charles P. Steinmet's ENGINEERING MATHEMATICS. Basic mathematical ideas are shown for their unity and simplicity, aiding students and engineers in using mathematics effectively.

Incorporating 80% of the mathematical procedures and methods needed in career engineering work, the book clearly explains methods and formulas. As a result, there will be little need for memorizing and less likelihood of misapplication of formulas.

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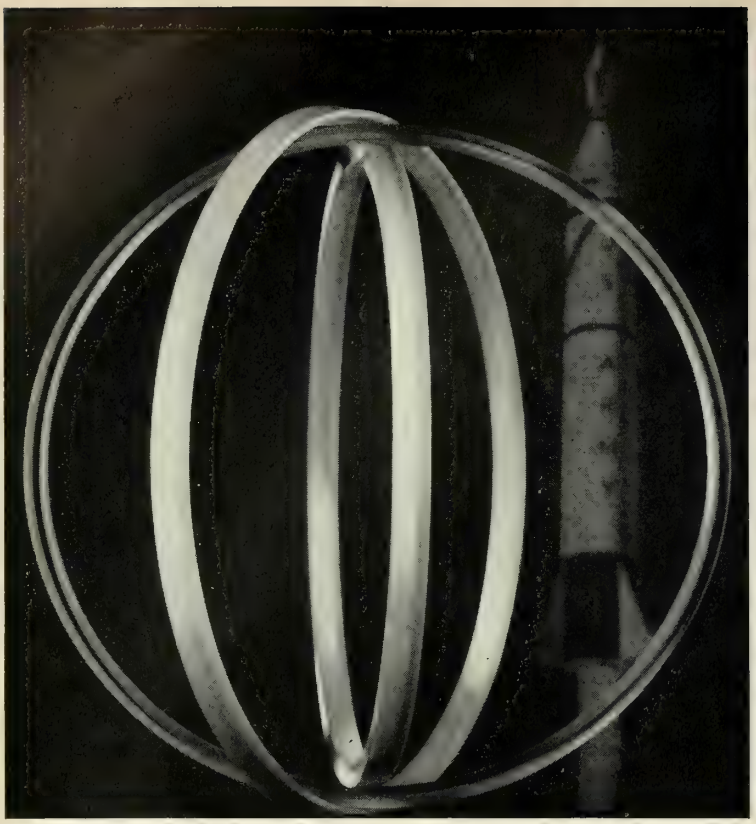
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advanced work. Special emphasis is put on infinite series, complex numbers, and nethods of approximation.

THERMAL STRESSES
by B. E. Gatewood, 232 pp. $7.50, McGraw-Hill Book Company, Inc., New York

Missile designers and analysts are constantly confronted with high-temperature problems. This book is the first on thermal stresses to cover all phases of the design problem at elevated temperatures.

Written for aeronautical engineers in particular, emphasis is on fundamental theory. This treatment is applicable to nuclear reactors, rocket motors, steam and gas turbines and guided missile structures, in addition to aircraft.

Topics discussed include temperature distribution; elastic and inelastic thermal stresses; combined applied and thermal stresses; allowable stresses of various materials at elevated temperature; and the buckling, deflection, stiffness, fatigue, shock, and flutter effects of elevated temperatures. Many recent advances in thermal stresses, temperature distributions, and material properties have been included.

Thermal stress calculation procedures developed are considered by the author as accurate as some other steps in the design sequence, and more accurate than temperature based on convective heat transfer calculations and the allowable compressive stress under creep conditions.

MAN-MADE MOONS
by Irving Adler, 128 pp., $2.95, The John Day Co., New York.

This is a small book which packs a lot of information from the launching of a satellite to the role the satellite will play as a prespace flight information gatherer.

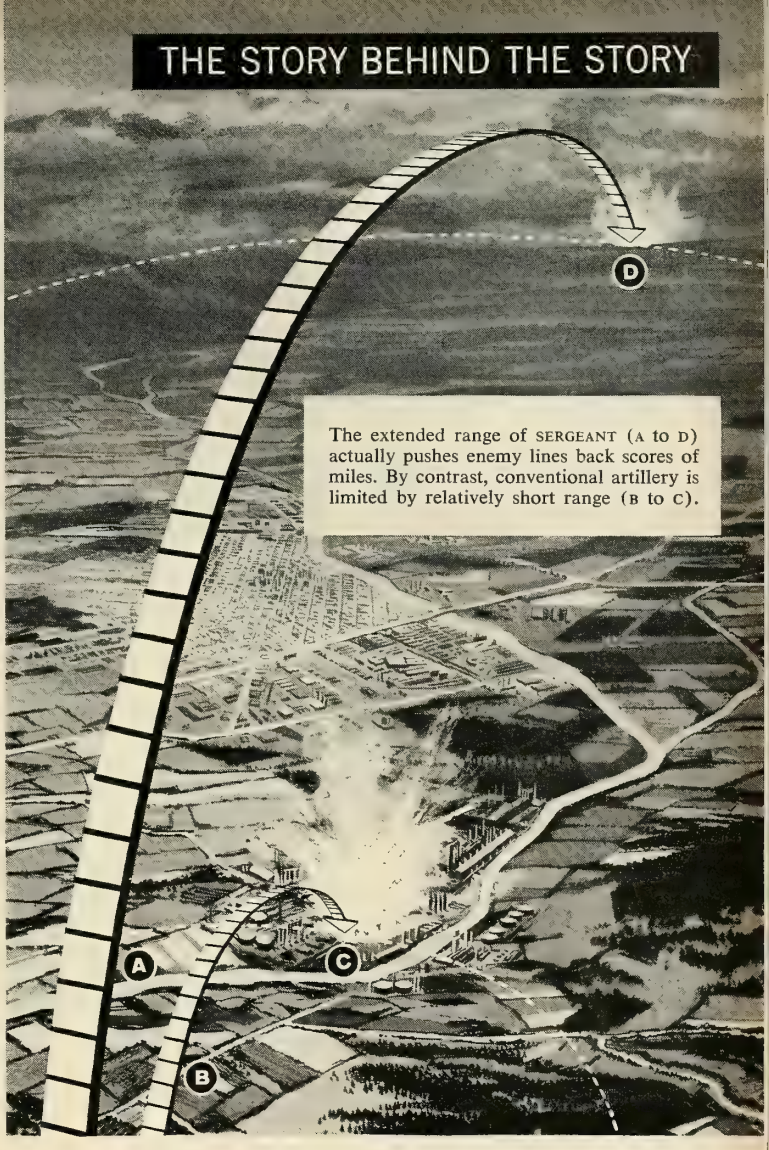
In extremely simple language Adler covers and dissects what is now known of the earth's upper atmosphere and what we expect to learn by penetrating higher into its mysteries. MAN-MADE MOONS explains how satellites, the first artificial, will give man a more accurate picture of his planet: its shape, crust, surrounding atmosphere, solar and cosmic rays, the ionosphere, "earth-shine," the earth's magnetic field, to name a few.

The text is illustrated by some fine simplified drawings by Ruth Adler. The team of Adler & Adler have collaborated on six other scientific books, including HOW LIFE BEGAN, TIME IN YOUR LIFE, and THE STARS: STEPPING-STONES INTO SPACE.

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Sperry's many contributions to the U.S. missile program, ranging from complete missiles to major sub-systems such as radars, automatic inertial guidance systems, electronic countermeasures, and automatic missile checkout systems, account for its selection as system manager for the production of SERGEANT.

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TV Guidance

Aircraft System May Be Applied To Missiles

Office of Naval Research's "Pathway in the Sky" system of TV-screen-presented instrumentation for high-performance aircraft, will definitely have application to manned space vehicles.

This "flying ribbon" concept, a development of the Army-Navy Instrumentation Program, started five years ago under sponsorship of ONR, BuAer and Army Signal Corps. The system will permit pilots to literally fly along a pathway displayed on a transparent TV-screen set into the cockpit windshield.

ONR says this type of instrumentation display would be required for reentry-type vehicles, such as the X-15.

The recently-unveiled system eliminates a pilot's need to read and interpret information from the clutter of dials in present cockpits. It gives him a three-dimensional presentation of the sky and ground.

Essential flight information—fuel consumption, flight plan, present position, destination and radio navigational data are programmed into a computer which gives a pictorial display.

For short penetration flights into nearby space, or even for short-time orbital flight, the system could furnish an invaluable reference to the pilot. It could link the thinking brain of its human operator to a space vehicle's automatic control system, furnishing information from great distances to allow time for decisions.

Such a pictorial display of information would have a tranquilizing effect on the pilot, for it would give him reasoning time for any changes in operational or environmental situations.

ONR estimates that approximately $15-million has been spent on this instrumentation program since its start five years ago.

No research funds have been particularly ear-marked for application to space-type vehicles, but ONR said such application is inevitable.

The El Segundo Division, Douglas Aircraft Company, Inc., is prime contractor and program coordinator for the program.

Douglas will have a space cabin mockup of the system at the Brussels World Fair. The Brussels display shows a guidance plane, bodies in space and a guidance path through these bodies.

The "Pathway in the Sky" display, including a thin television-type cathode ray tube which enables the display to be set into a cockpit window, was designed and developed by Kaiser Aircraft and Electronics Division.

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Missile Trainer Simulators

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The test console depicts a typical simulation device utilized for the "dry run" of a missile and its components; significant advances have been made in the art of simulation to train personnel in missile operations.

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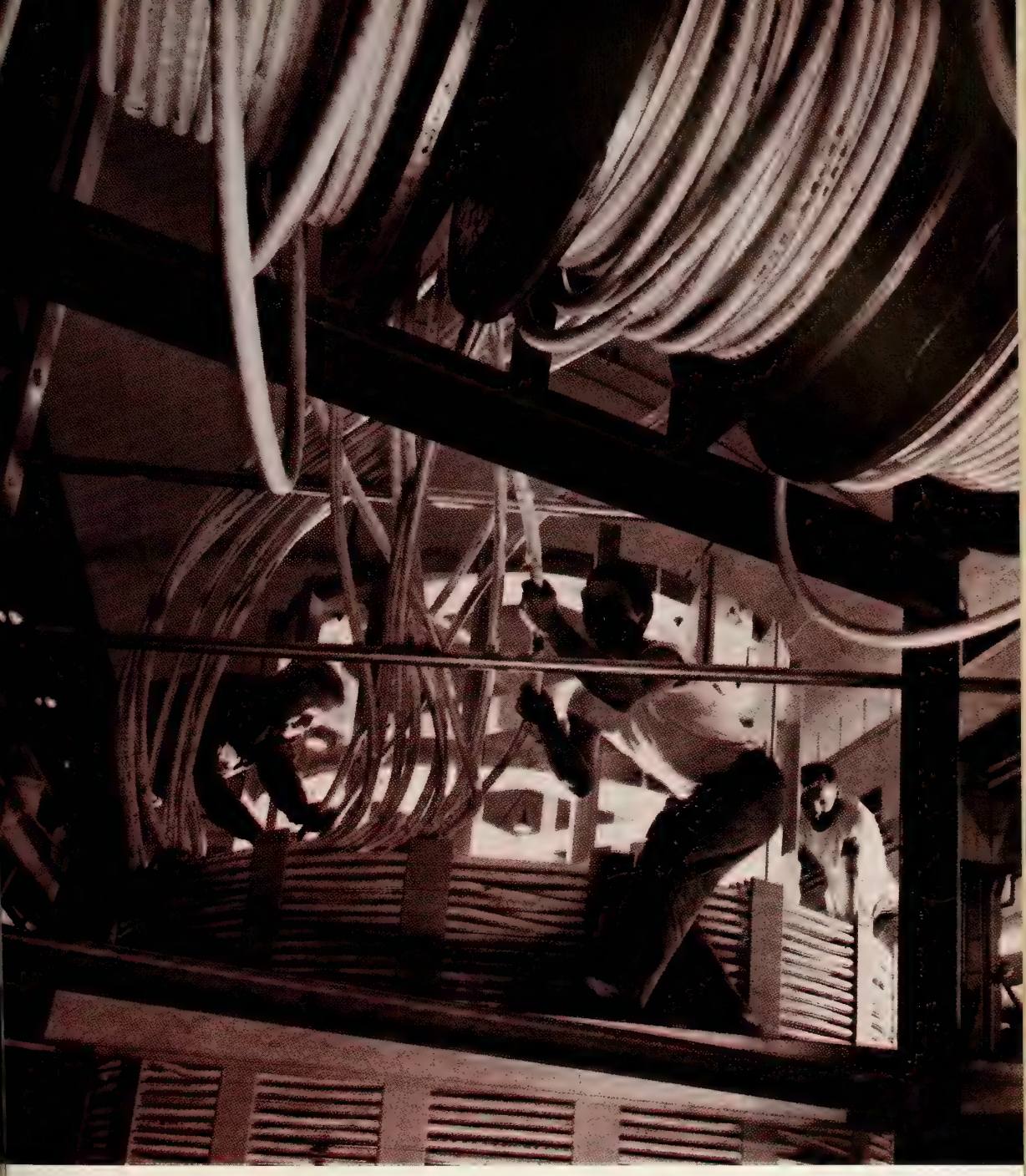
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WHEN "MINUTES" COUNT

SYNCHRO FUNCTION	CPPC TYPE	PRIMARY Input Voltage (400~)	PRIMARY Input Current (Amps.)	PRIMARY Input Power (Watts)	PRIMARY Output Voltage (Volts)	PRIMARY Sensitivity (MV/deg.)	PRIMARY Phase Shift (deg. lead)	D.C. RESISTANCE Rotor (Ohms)	D.C. RESISTANCE Stator (Ohms)	IMPEDANCE Zro (Ohms)	IMPEDANCE Zso (Ohms)	IMPEDANCE Zrss (Ohms)	Max. Null Voltage (MV)	ACCURACY Max. Error (Min.)
Torque Transmitter	CGC-8-A-7	26	100	5	11.8	206	III	37	12	54 + j260	12 - j45	80 - j20	30	7
Control Transformer	CTC-8-A-1	11.8	090	.2	23.5	410	9	150	24	212 j684	22 j115	246 j60	30	7
Control Transformer	CTC-8-A-4	11.8	029	08	22.5	390	8	389	64	560 - j1860	90 - j340	640 - j190	30	7
Torque Receiver	CRC-8-A-1	26	100	5	11.8	206	III	37	12	54 - j260	12 - j45	80 - j20	30	30 sp.
Electrical Resolver	CSC-8-A-1	26	038	.42	10.8	190	20	230	27	286 j620	45 - j148	350 - j75	30	7
Electrical Resolver	CSC-8-A-4	26	038	42	26	454	20	230	170	286 j620	250 - j830	350 - j75	30	7
Control Differential	CDC-8-A-1	11.8	085	21	11.8	206	9	36	25	38 - j122	27 - j120	48 - j14	30	7
Vector Resolver	CVC-8-A-1	26	057	34	11.8	206	10.2	78	27	103 + j440	8 + j30		30	7



ACTUAL SIZE

Count on CPPC Synchros

In the above diagram, which simulates the attack of an ICBM and its destruction by an Anti-Missile Missile, only 20 minutes will elapse from the time advanced radar picks up the ICBM at point a and the time ICBM reaches its target. These are a vital 20 minutes.

In these 20 minutes the path of the ICBM must be computed with extreme accuracy and the intercepting path of the Anti-Missile Missile computed equally accurately.

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missile electronics vol. 1, no. 7

contents

missile electronic news

Titan **Guidance System Speeded**

Computer Speeds Missile Support **233**

New System Measure Atlas Weight & Thurst 230

Radar Monitors Ionosphere Tests **234**

special features

New computer system speeds missile work. Packard-Bell Corp's TRICE computer combines features of both analog and digital techniques.

The TRICE, soon to be installed at the Army Ballistic Missile Agency's Computation Lab, is described by m/r editor Peer Fossen (p. 207).

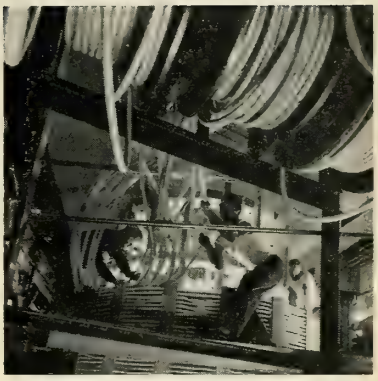
Thermistor speeds pre-launch check. Wider application of temperature-sensitive resistors seen.

R. L. Biesele, Jr., of Fenwal, Inc., discuss some aspects of thermistor applications in missiles (p. 213).

In-line relay cuts launching delays. A new answer to a constantly recurring problem.

m/r editor Raymond M. Nolan outlines features of a new relay concept where the relay actually becomes part of the missile cabling system (p. 219).

cover picture:



Pictured undergoing assembly is the world's largest inductance coil, which will permit research into many areas of astronautics and aerodynamics. Built by Westinghouse Electric Corp.'s Transformer Division, the coil will supply energy to an electric-arc tunnel for testing missiles in the Gas Dynamics Facility at the Arnold Engineering Development Center, Tullahoma, Tenn. The coil is similar to that used on a current-limiting reactor—except for the vast difference in size. A normal current-limiting reactor is wound with two or three 500-mcm cables; this coil is wound with 36 850-mcm cables in parallel. The coil is 119 inches in diameter, compared with 35 inches for a current-limiting reactor.

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New extreme-high-temperature lubricants for missiles and supersonic aircraft **SHELL ETR GREASES**

One of the serious lubricating problems faced by designers of missiles and supersonic aircraft has been solved by scientists at Shell Research Laboratories.

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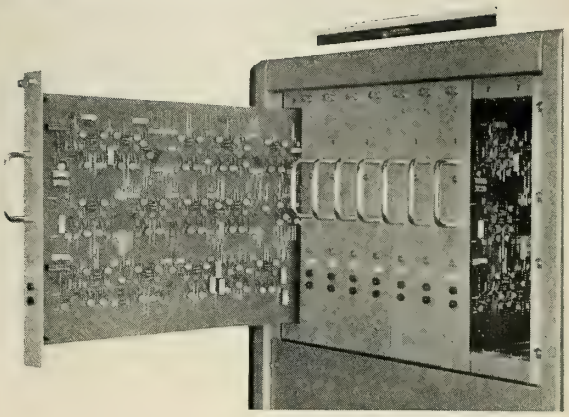
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New Computer System Speeds Missile Work



by Peer Fossen

RAPID EXPANSION of the computer applications in missile technology has forced development of a new system combining both analog and digital techniques.

The new system is Packard-Bell Corp.'s TRICE (Transistorized Real-time Incremental Computer—Expansible). The concept of TRICE and its subsidiary equipment is a breakthrough in accuracy and speed for the control systems and calculations required by the race for space.

According to Packard-Bell, the TRICE will be placed in operation by the Army Ballistic Missile Agency's Computation Center at Redstone Arsenal this spring. A prototype system will be used to demonstrate the new digital techniques and acquaint personnel with the new concept.

The impetus for TRICE came from individuals with analog computer experience who felt that analog systems are not sufficiently accurate, especially when dealing with nonlinear systems. Other limitations encountered concerned difficulty in setting up complex problems involving many amplifiers and nonlinear equipment.

Although automatic setup equipment for analog computers has been available for some time, it is "hung on" rather than integral to the system. This equipment is largely electro-mechanical, whereas digital equipment is completely electronic.

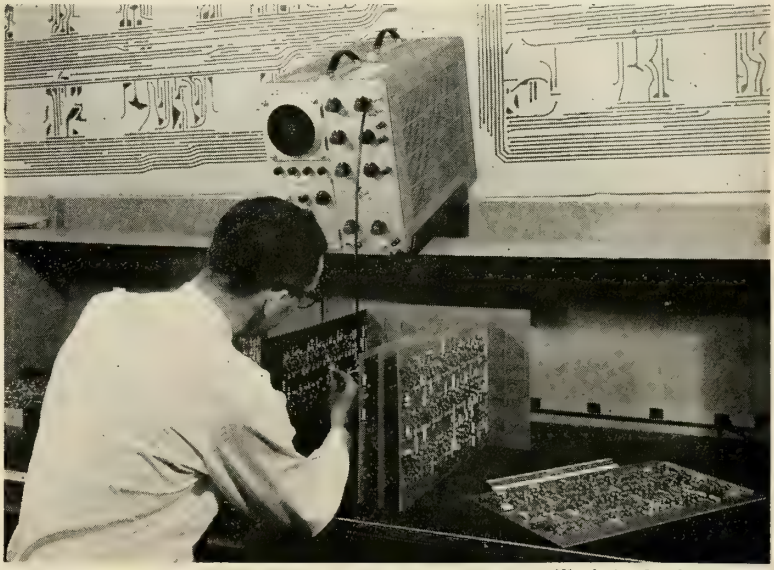
A first result of efforts to combine the two computer techniques, TRICE is claimed the fastest digital computer built. Operating at an iteration rate of 100,000 per second, the system combines the expansibility and ease of programming of analog computers, with the precision and repeatability of digital computers—at a speed that makes possible real-time digital solutions of such problems as missile simulation flight.

• **Basic elements**—The TRICE computing elements are basically five in number: three incremental computer building blocks, a digital function generator and an analog-to-digital, digital-to-analog conversion system. All are completely transistorized.

The three incremental computer blocks are an integrator, a multiplier and a digital servo. The integrator is similar to integrators in existant serial digital differential analyzers but with important differences. First, it is physically independent as are the amplifiers of an analog computer. Secondly, it operates at very high speed; will integrate a given variable with another variable—not necessarily time—100,000 times per second.

It is difficult to compare digital computing speeds with analog responses, but, roughly, this integration rate corresponds from 10 to 20 cycles. Lack of restrictions on the independent variable generates both linear and nonlinear functions by the same computing element.

Integrators employ an integration formula and an intercommunication scheme that minimize errors for parallel digital computation. The quadrature formula employed is a modification of the extrapolative form of trapezoidal



All photos by donn maur.

FIG. 2. Technician checks plug-in modules prior to assembly on plug-board.

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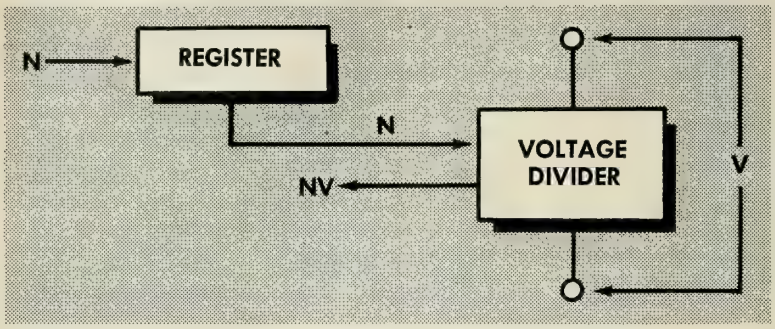


FIG. 3. Digitally-controlled voltage divider unit of the MULTIVERTER.

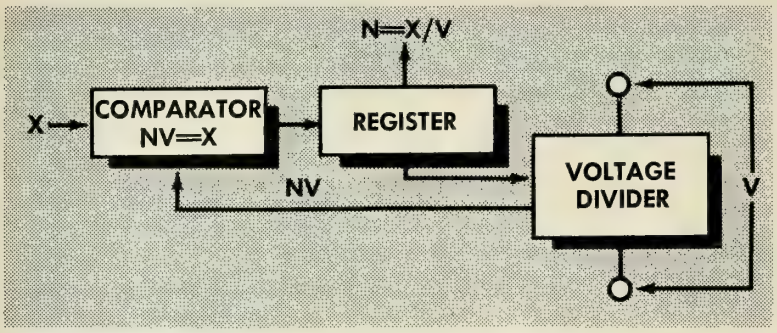


FIG. 4. Bi-directional counter used in the analog-to-digital converter.

integration. This not only provides a second-order correction, but partially corrects the time lag introduced by the parallel mode of operation. The interconnection scheme makes it possible for the information interchanged among computing elements to have three values: +1, 0 and —1.

In operation, stable sine waves of several hundred cycles have been generated.

The basic integration unit can generate both linear and nonlinear functions. For convenience, a multiplier unit has been developed. This generates increments of the product of two functions, given the two functions in incremental form. This unit also operates 100,000 times per second and yields exact products.

The third element is a digital servo. This unit generates inverse functions such as square roots, arcsines, etc. It may be thought of as the digital analog of a high-gain amplifier that produces a maximum output for any magnitude input error signal. Resolvers and other special elements probably will be constructed. While subject to truncation and round-off errors, the TRICE, being digital, is not subject to drift, and can be employed to solve real-time problems that, like certain trajectory calculations, require long computation.

• **How it works**—These three elements theoretically are sufficient to generate any analytical functions produced by an electronic analog computer. Because of cost and other considerations, this equipment can generate one or several of the loops in a problem while standard analog equipment is used to generate the remainder. In this case, a conversion system is required to transfer information between the two computers.

The first requirement of such a conversion system is high accuracy—0.01% of full-scale. This full-scale accuracy is particularly needed if small values are to retain a reasonable degree of accuracy.

The other requirement is a 10-microsecond conversion time. An incremental converter can be used here since the amount of information that must be transferred over each channel precludes multiplexing a single converter among many other variables. An incremental converter is one where a bi-directional counter follows the input wave form. The limitation of this device is the same as the computer—it can change by 100,000 increments per second with no reduction in frequency response.

• **Conversion System**—Packard-Bell also has developed a novel conversion system, the MULTIVERTER. Heart of the system is the digitally-controlled voltage divider shown in Fig. 3.

Given a number, N, and a voltage, V, this device will generate NV so that in going from a digital computer loop to an analog loop, a multiplication can be performed with an accuracy of 0.01%.

If this voltage divider is employed to provide comparison voltage into a comparator, and causes the bi-directional counter to go up or down, the result (as shown in Fig. 4) would be an analog-to-digital converter.

The comparator, in this case, compares the input voltage, X, to the output of the digital voltage divider, NV. The counter is changed to make these quantities equal; hence. $X = NV$ or $N = X/V$. This means, in going from an analog loop to a digital loop, that the conversion system will generate the digital value of the quotient of two of the analog variables. The converter's incremental outputs are at the central plug-board and are completely homogeneous with the incremental signals generated in the computer proper.

• **Functional generator**—The final component is a digital function generator.

Photographic techniques store the values of the independent and dependent variables on a small strip of film.

Several methods are variable for operating upon the values as they are read. The most straightforward is to store the dependent variable incrementally so values can be treated the same as the incremental outputs of the computer elements and the conversion system. Limitation is that the function can vary only a small number of increments for each stop of the independent variable.

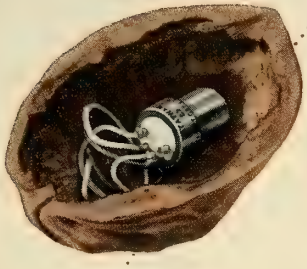
In certain cases, the arbitrary function has abrupt steps or other discontinuities. For this reason a function generator supplies the value of a function for a given argument rather than incremental values.

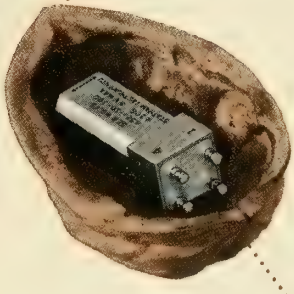
Being a mechanical device, the function generator cannot supply 100,000 new values per second. For many tasks, this high speed is not required, but in some cases new values of the dependent variable must be supplied as a rate almost as high as the iteration rate.

In these cases, the number stored is the first or some higher difference. By employing one or several integrators, this difference value can generate functional values at the required rate, although the difference value changes relatively slowly. A similar system for analog computers is also under design.



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Component aircraft parts . . . gyros, cameras, computers, servos, batteries, antennas, to name just a few . . . must be heated when exposed to the freezing environment at the altitudes at which jets fly. Also needed at low operating temperatures are de-icing units for propellers, wings, vertical fins and horizontal stabilizers.

Apparent, too, is the marked growth in the usage of heating blankets to satisfy winterization needs and demands of certain types of refrigeration units for satisfactory defrosting methods.

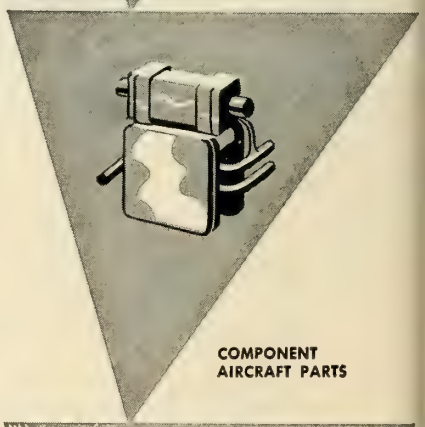
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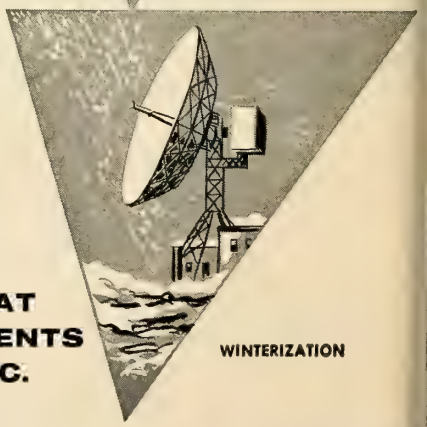
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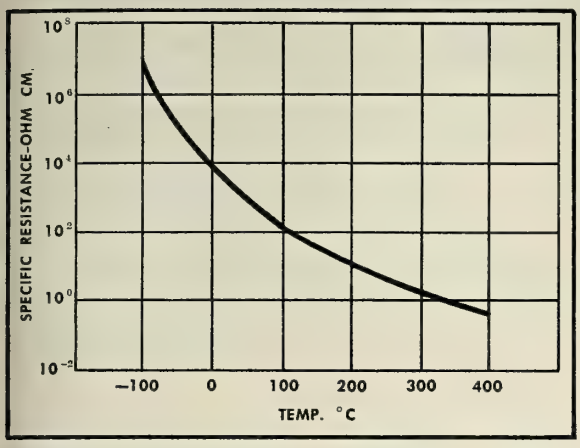
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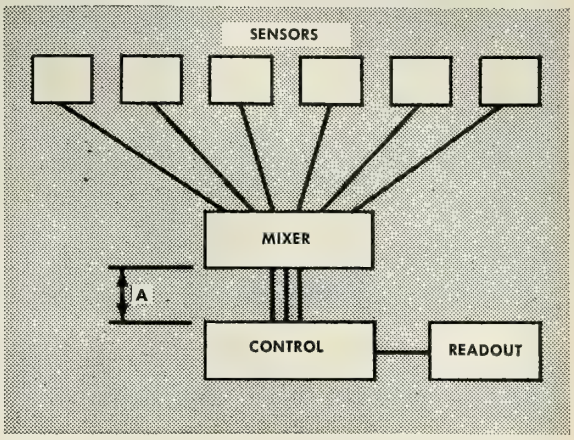
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RESISTANCE-TEMPERATURE characteristic of a typical thermistor. Note particularly the large resistance change for relatively small temperature changes.



SCHEMATIC of typical thermistor system for missile ground check-out. Sensors and mixer are installed on missile, other components on ground. Distance "A" can be 250 feet or more.

Thermistor Speeds Pre-Launch Check

by R. L. Biesele, Jr.*

THE MOST IMPORTANT element in missile operation is temperature. It is an, ever-present consideration in selection of material for construction, and is equally important to the operation of equipment used on the missile.

To provide a definitive listing of all the temperature considerations in missiles is extremely difficult, so this article is concerned only with a system concept that is applicable to ground check-out of temperature.

Two general areas are involved: storage of the missile to insure that it is both safe for personnel and in a high degree of readiness; check-out during the immediate pre-firing period, or countdown.

During the countdown, temperature check-outs not only determine the operability of the missile, but are also used as controls on certain parts. An example would be the air conditioning equipment used to hold various sections of the missile at specified temperatures. Ground control equipment can be used for this function: once the missile has been fired, its flight time is sufficiently short so that, with proper equipment design, no serious temperature variations will occur.

An important area of ground check-out is the engine, which must be warm enough to insure that valves do not stick, and that other components operate at maximum efficiency. This problem is complicated by liquid fuels, such as liquid oxygen, which involve extremely low temperature, and by the wide varieties of climates in which the missile may be used.

Communication equipment also requires temperature check-out. Crystals, transistors, and many other electronic components change value significantly with temperature variation.

The guidance system is the most important area of temperature control. All inertial guidance systems have precise temperature control built in to maintain operability throughout the missile's flight. During count-down, all systems must be checked to ascertain that they are within specified temperature limits.

• **What's a Thermistor?**—Obviously, any type of temperature measuring device can be considered for check-out, and, in fact, many types are used. Miniature thermal switches are commonly used on the missile itself. Thermocouples, resistance bulbs, and many others also find their places.

One type of temperature measuring system that is gaining wider application and usefulness is based on thermistors.

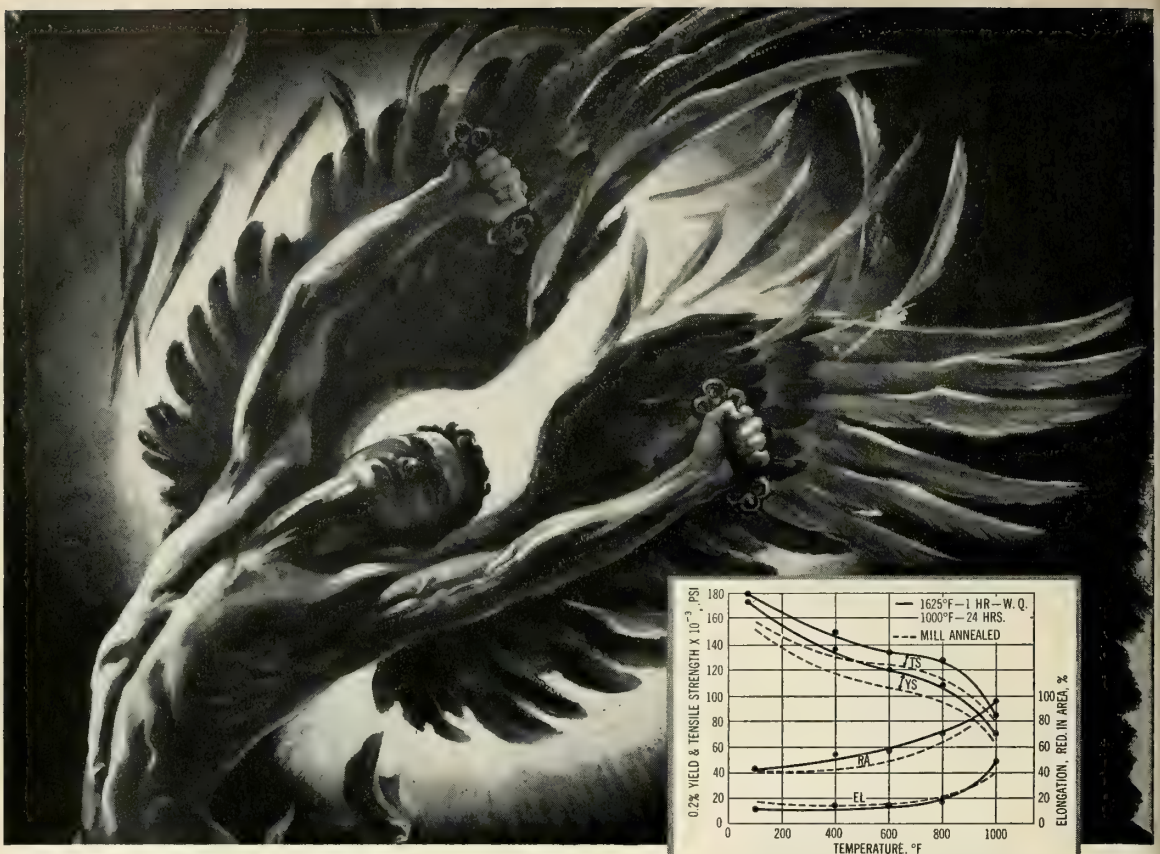
A thermistor is no more than a temperature-sensitive resistor which has a negative temperature coefficient of resistance. This characteristic, which is fixed, predictable and stable, is illustrated in the accompanying graph.

In missiles, thermistor systems include sensing probes, which are the thermistors themselves, a mixer to consolidate information from several probes, a control unit to interpret this intelligence, and a read-out (diagram).

Missile check-out systems must have, among other specific characteristics intrinsic to the application, full consideration of reliability, speed, accuracy, simplicity, weight, size, and, of course, cost. These apply to any system, and are not peculiar to thermistors. Nevertheless thermistor systems should be analyzed in terms of these broad considerations:

Reliability—Here the need is not only for the reliability of the system itself, but the reliability of the information it provides. A check-out system which compounds the complexity of

*Project Supervisor, Electronic Design Fenwal Incorporated, Ashland, Mass.



Tensile Properties vs. Temperature of Heat Treated Ti-155A

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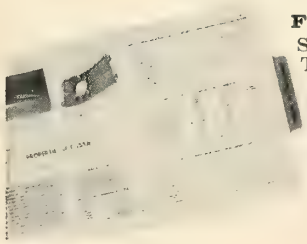
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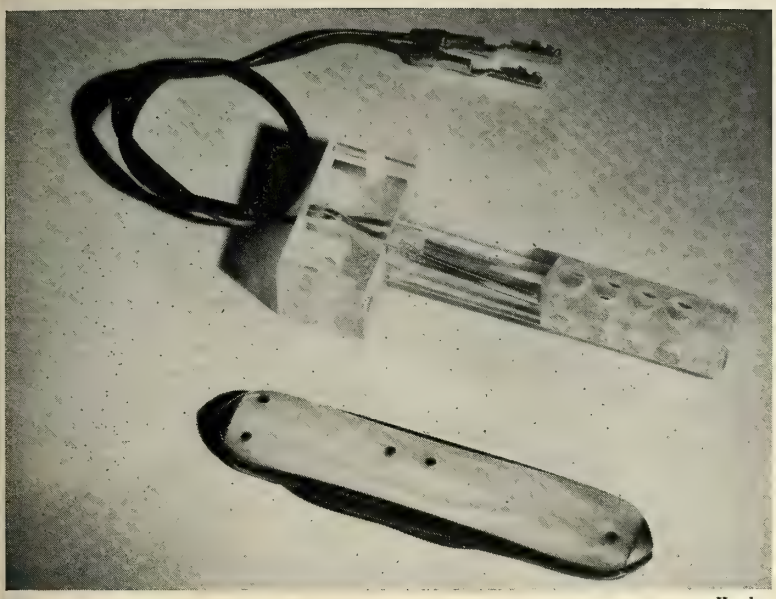
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Korday

TYPICAL thermistor probe used in missiles. Thermistor is encased in plastic, and housing is perforated to permit fast response. Pocket knife gives size comparison.

the weapons system is an absurdity. Thermistor systems offer many advantages in this area.

First is the fact that thermistors are among the very few electronic components that do not depreciate with age.

It will be noted, too, (on the graph) that there is a large change in resistance for a small change in temperature. This means that a thermistor has a large "signal" output, particularly in comparison with such devices as thermocouples.

The large signal permits simplified associated circuitry; extensive amplification is not required, nor are extremely sensitive relays. In fact, under certain circumstances, both amplifiers and relays can be eliminated, making possible a system without moving parts and with consequent increases in reliability of action.

The high "signal" also produces simplified wiring. Not only does the mixer consolidate information and thus reduce wiring, but the number of connectors required is substantially reduced as compared to other design approaches used.

Accuracy—This is a corollary of reliability, yet it also implies the ability to detect minute temperature changes—of particular importance where the temperature is critical and a tiny variation can have serious effects on missile performance. In addition to the large resistance change for a small temperature change, which makes the thermistor more sensitive than many other types of sensing elements, there must be added the small size of the thermistor—they can be made the size of a fly speck—which means a low thermal mass that is extremely responsive to environmental changes.

Obviously, accurate readings are not only necessary to control to the close tolerances required in missiles. They are essential so that the transmitted information becomes sufficiently meaningful to produce proper corrective action.

Speed—A major problem is to activate the "bird" as quickly as possible after the command has been given. To the temperature check-out system, this means that the information sensed must be transmitted virtually instantaneously, and that there must be a maximum of time allowed for corrective action where necessary.

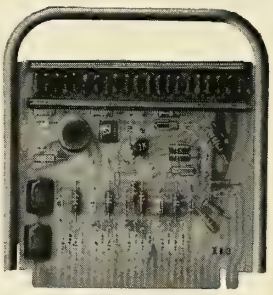
For this, the thermistor provides inherent technological advantages. First, the system is completely electronic and independent of any mechanical linkages. It does not require tubes of any kind and eliminates the essential warm-up period such components require. Thermistors are small and can react virtually instantaneously.

With respect to speed, many missile

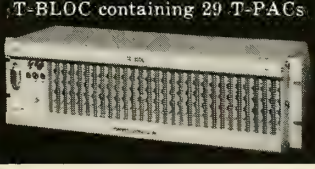
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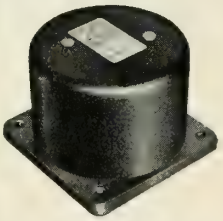
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thermistor systems are designed to provide passive, continuous check-out. In these cases, the system is operating at all times and automatically signals whenever a fault occurs.

Weight—It has long been a rule of thumb that in a large missile, each pound saved adds one mile greater range. Conversely, it is also important to have ground equipment as light and portable as possible, for maneuverability and transportation. Insofar as the missile itself is concerned, the probes that would be mounted thereon can thus be fly-speck size, with a weight that is measured in milligrams. Furthermore, by mounting the mixer on the missile, the weight of necessary wiring is also substantially reduced.

But what of the ground equipment? Here, the weight will be a function of the amount of information desired. If recorders, analyzers, and similar equipment are needed, the weight will be proportionately greater. However, the nature of the thermistor, its high signal output, less need for extensive wiring, amplifiers and relays—all will aid materially in keeping weight—and size—of ground equipment within manageable proportions.

Size—In the vast reaches of outer space, space is at a premium. This paradox is a major problem for the designer, that could be solved by the small size of thermistors and their associated control units.

Cost—As every engineer knows there is no such thing as "Damn the cost." In missile check-out systems—as in all other equipment—cost consists of two elements: the material cost of the unit itself and the cost of designing or engineering a particular system.

We can dismiss the former very quickly, for actual material cost is but a small part of the total for a thermistor system or any of the alternative approaches. However, it can be stated that thermistors can often be made for much less than other temperature-sensing devices with applicability.

Nevertheless, it is the engineering costs we must consider. Since missile requirements are so often for one or two units for prototype testing, or the actual production quantity is not in the realm of so-called "mass production," engineering charges that would otherwise be amortized become very significant.

Here a thermistor system offers fundamental advantages. First, the overall concept of its operation is rela-

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tively simple, in the complex of missiles.

The elements of this diagram are common to every system; the design problem is to tailor each to the specific nature of the application.

It is of relatively little importance in the design, for example, whether a system has 10 or 50 sensing elements. The thermistor sensor itself can be easily adapted into nearly any desired configuration. Control, mixing and read-out components can be grouped into a few interrelated designs which, by choosing the desired combination, can be adapted to virtually any requirement. In view of these factors, engineering costs on thermistor systems can be proportionately less than for other systems that may vary substantially with the application.

• **Typical System**—Let us look at a typical general thermistor system, consisting of sensing elements—the thermistors, a mixing network, a control unit, and a read-out. Such a scheme is shown in the block diagram.

Sensors are mounted at those points within the missile upon which a temperature check is desired. Each sensor is, in turn, connected with a mixer through the simplified wiring discussed previously. The mixer, which consolidates the information from several sensors, is also generally mounted on the missile and is expendable upon firing. Such mounting is particularly desirable since it cuts down on the number of wires running out of the missile, and significantly shortens their length and cost.

Though several sensors may feed information into the mixer, only three wires are needed to connect it to the control unit, which is located on the ground.

The control, which translates the information received from the sensors, can be designed to accomplish a number of functions.

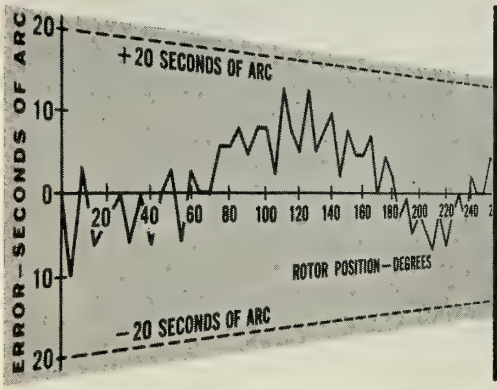
The control unit, in turn, actuates the read-out; the type of read-out used being, naturally, a function of the overall system requirements.

Systems incorporating many of the principles described here are now being actively considered by many missile engineers.

Interestingly, the general capability of monitor systems is not limited exclusively to temperature control. It can, with reasonable effort, be extended to include pressure, acceleration, voltage, or any other parameter which can be translated into voltage.

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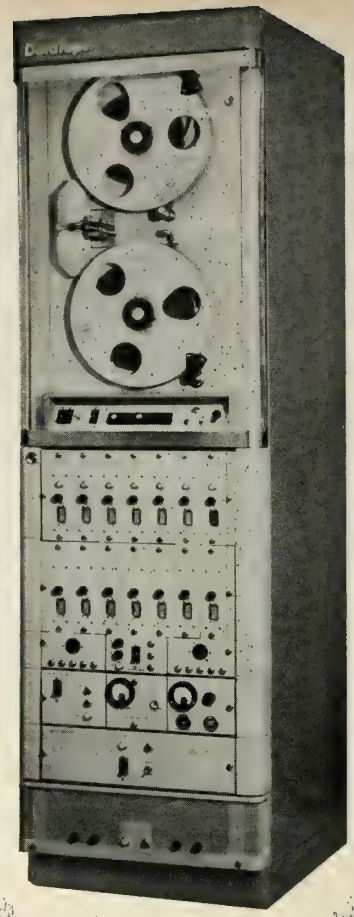
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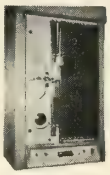
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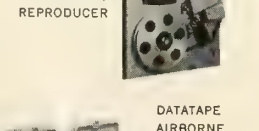
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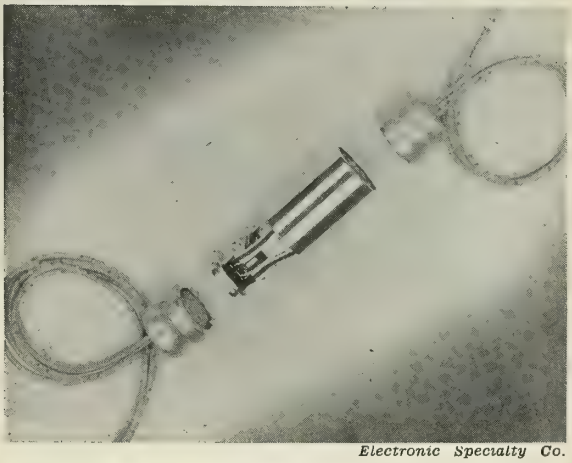
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In-Line Relay Cuts Launching Delays

by Raymond M. Nolan

COUNTDOWNS in big missile shoots oday are, at best, a trying and frus- rating experience.

Time after time a halt must be alled because of the failure of some prosaic component such as a relay or valve.

Most solutions center around metic- ilous checking of each tiny part be- ore the countdown begins. But if fail- ure occurs after the pre-firing pro- edures are in progress, nothing can e done except trouble-shooting and eplacement of faulty components.

Electrical relays are especially sus- eptible to such failure and to another ven more important trouble—failure n flight. Much work is currently being one to improve this situation. Oc- asionally an idea which can truly be alled a breakthrough becomes a eality.

Something new in this line was re- ealed recently—an in-line relay with ll cables connected axially and the nit suspended directly in the cable in.

This new device, developed by lectronic Specialty Co., Los Angeles, alifornia, promises to alleviate—if ot abolish—most of the difficulties hat are now encountered in missiles ith relays.

The in-line relay may be placed nywhere in the missile cable runs. is supported by the cables themselves and therefore virtually immune to shock and vibration. Damping effect of the cable mounting is so complete, that no measureable motion of the relay is registered when the cable ends are vibrated through the complete frequency range outlined by Mil Specs.

• **Tiny and tough enough?**—Missile guidance and control today is dependent on literally hundreds of relays to perform essential sequencing of electrical operations. Since the switching function is performed by closing a gap as small as 0.05-in., it is clear that these units must be rugged and reliable if accidental tripping due to vibration, shock, arcing or high-temperature expansion is to be avoided.

Traditionally, these dangers are met by grouping the relays in relay control boxes and mounting them rigidly to the airframe; but increasing missile speeds and altitudes are rapidly outmoding such a solution. One example is the skin friction heating generated by supersonic speed. These temperatures are transferred through the structure into the relay and are now handled only by the use of high-temperature materials and forced cooling of the components.

Another problem in control is the marked reduction in air density as missile operating altitudes are progressively increased.

This results in rapid loss of insulating properties of the atmosphere in the relay terminal gaps with ultimate arcing across the gaps, even when hermetic sealing is used.

The progress in miniaturization made by the relay industry over the past decade has created tiny units that weigh only a few ounces and occupy less than a cubic inch of space. But this miniaturization has meant shrinkage of the distance between terminals with accompanying corona discharge and arcing risks.

In the in-line relay, the high potential difference between the power cable ends controlled by the relay is separated at opposite ends of the unit, providing the maximum possible protection against arcing and corona discharge. This arrangement also reduces the effect of stray capacitance and other residual electrical properties that plague single-end relays.

• **New answer**—The new "straight-through" relay design, subject of a military specification to be issued shortly and covered by recently-awarded Patent No. 2,825,782, avoids most of the difficulties mentioned above.

The new unit is, essentially, a conventional sub-miniature relay of tested and proved specification performance, but secured in a radical new mounting.



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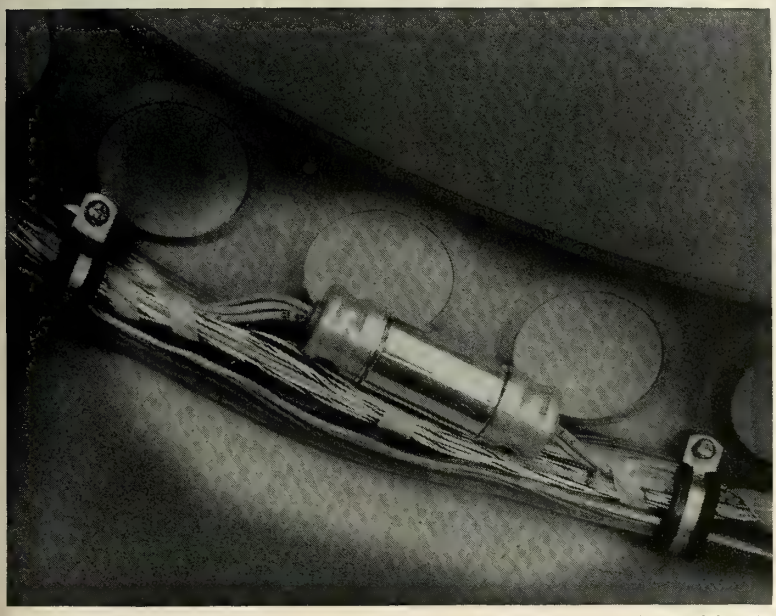
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IN-LINE RELAY is mounted in the wire bundle, anywhere within the missile and thereby isolated from structural heat or vibration-transfer into its interior.

While the conventional single-end relay mounting produces a sunburst of wiring in which the relay is the fulcrum of a tug-of-war, the new design makes obsolete the connection problem by routing all input wiring into one end and bringing all output wiring out the other end.

The fact that the new relay can be freely mounted virtually anywhere with the missile structure, opens many new design concepts for the engineer. In most cases, it will no longer be necessary to run high-powered cable through large connectors into pressurized areas for such purposes as protective circuit-breaker reset. Instead, the remotely-located circuit-breaker can be reset by a slave in-line relay actuated by a small control line.

The in-line relay can be located inside access doors situated for other purposes, for example, and requires no brackets or clamps for securing.

• **Eases repair**—Trouble-shooting—and especially trouble-shooting during countdown—in missiles has multiplied in difficulty with the increase in electrical complexity and much of this maintenance burden involves the search for faulty relays in a maze of relay wiring.

In some cases, literally hundreds of wires pass through a relay control box. The rapid and correct identification of individual wires tests the capacity of maintenance personnel in addition to wasting precious time prior to missile firing.

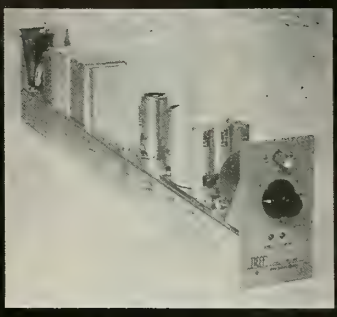
However, maintenance of in-line relay-equipped missiles would only require the mechanic to break out the wire bundle and replace the relay with two twists of the wrist, instead of the currently-required backing off of nuts and their replacement in cramped quarters.

The installation completely eliminates mounting brackets with an attendant decrease in weight. Merely multiply the saving in weight by the number of units in an average large-size missile—this factor alone makes installation of in-line relays worthwhile.

This promising development shows an interesting new trend by adding a new duty to a component (supplying its own mounting function) rather than the usual search for means of taking away duties performed by a functional unit.

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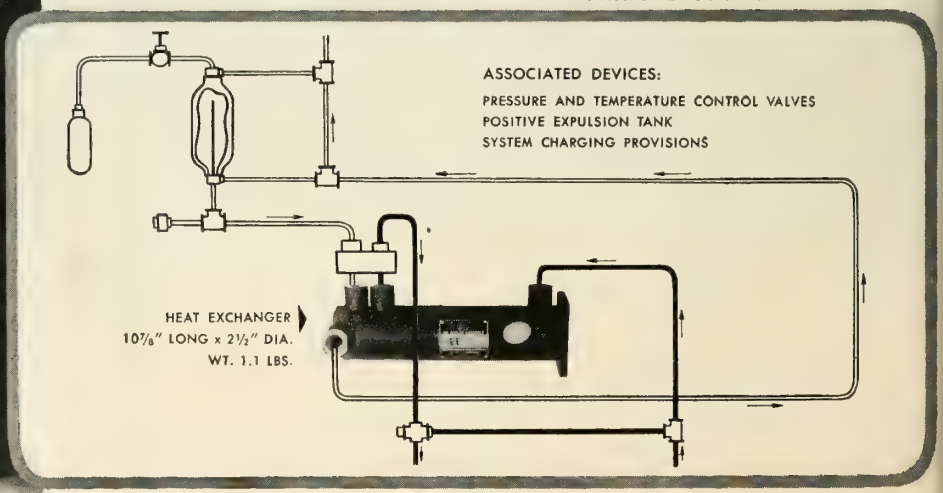
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Titan Guidance Program is Accelerated

USAF's most sophisticated system draws near operational status as manufacturer expands

by Raymond L. Nolan

Production of what is probably the world's most sophisticated inertial guidance system is currently being accelerated by a large-scale expansion program underway at the Arma division of American Bosch Arma Corporation.

Parts of the *Titan* guidance and control system—originally scheduled for manufacture at the old Studebaker plant at Midway Airport in Chicago—are now being manufactured in Long Island.

Arma is leasing space in Hicksville, L.I. at the present, but has added 20,000 sq. ft. of space at its Roosevelt Field location recently and indications are that more space will be provided as needed.

• **Transfer helps**—This transfer of the program from Chicago has placed Arma in a favorable position compared to most other Long Island manufacturing companies, which are definitely feeling the pinch caused by stretchout of their respective programs. In round figures, Arma employed 4,800 people prior to the stretchout, reduced to 4,500 before transfer of Chicago operations, and currently has 5,100 people on the payroll.

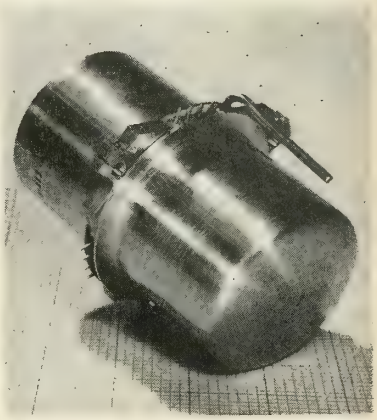
Just how many of these people are actually connected with the *Titan* program is difficult to estimate, because of the intermingling of the B-52 tail turret work with the *Titan* work. However, all of the expansion is for *Titan* alone.

One phase of the expansion is the addition of a third "sterile" room for assembly of gyroscopes and accelerometers.

Projects now underway include the installation of new air-conditioning, a vacuum system for the sterile room, insulated walls, drop ceiling, and tile floors. In fact, for really critical operations, there are "sterile areas" within the "sterile" room where only the hands of the assembler get near the hardware.

Equipment is being installed in the roow now, although there is no time set for its use. The first two "sterile" rooms are off limits for security reasons, but the new room has provision for around 70 production workers, so this probably places the number of people in gyro and accelerometer assembly at somewhere between 150 and 200. Add to this the 1,000-odd engineers and other production and test workers for the normally-assembled parts of the guidance system and the spending level probably reaches something like $55 or $60 million per year.

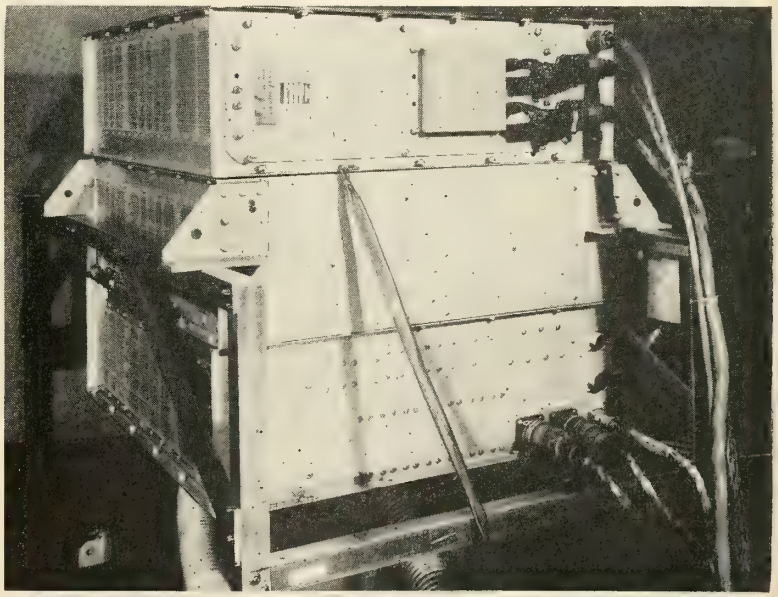
This figure is in line with AF Ballistic Missiles Division's chief, General Schriever's recent statement that the entire *Titan* guidance program from inception through presently-ordered production units totals $140 millions. Approximately $51,000,000 of the funds have been expended through the 15th of March, 1958, with the remainder reflected in the Company's backlog of military orders, currently estimated at $165 million.



VIBRATING-WIRE type accelerometer used in the *Titan* Guidance and Control System. Two such units are used to measure range and lateral deviation from course.

• **Guidance details**—Although details of the *Titan* guidance system are still classified, enough information has been released to define the system in a general way.

Basically, the Arma guidance and control system comprises a Control



GUIDANCE COMPUTER from *Titan* System. Unit is assembled in three decks and uses group of 6 x 9 in. circuit cards. Germanium semi-conductors are used throughout. Redundant connections make the possibility of failure from wiring failures remote.

Central, a Guidance Computer and a stable platform with two gyroscopes and three accelerometers. Information about the Minneapolis-Honeywell elements of the guidance and control system has never been revealed, but M-H seems to be connected to the pitch programming, engine control, and in-flight stability problems of *Titan* guidance and control.

The control central feeds servo power, temperature monitoring and other control functions to the inertial platform.

The digital guidance computer produces control signals from received and stored information, to keep the missile on course, and provides engine cutoff signals to the sustainer and vernier engines. The guidance computer is assembled into three decks and occupies a two-foot square, about two feet deep.

All the circuitry is built around solid-state elements and assembled onto 6x9-inch cards which are then encapsulated. Germanium transistors are used throughout. Almost 1,000 are used for the complete computer.

Redundant connections are used throughout to lessen the possibility of failure under missile flight conditions.

While the primary purpose of the guidance computer is to solve the cutoff equations for sustainer and vernier engine cutoff, it also includes the pitch programming device with some sort of a hook-up to the Minneapolis-Honeywell elements of the guidance system. This unit is a diode matrix and can store information for a total of four targets. If the target selected should not be one of the four, the unit must be removed and another one installed, not a difficult operation as Arma has provided for quick removal.

Other guidance systems, such as the *Jupiter*, make use of magnetic tapes which must be changed in accordance with the target so the relative inflexibility is not unique with the *Titan*.

• **Future development**—Arma's future plans for the guidance computer are interesting—a two-stage program is designed to reduce the weight from the present weight to "something really small," in the words of one Arma engineer.

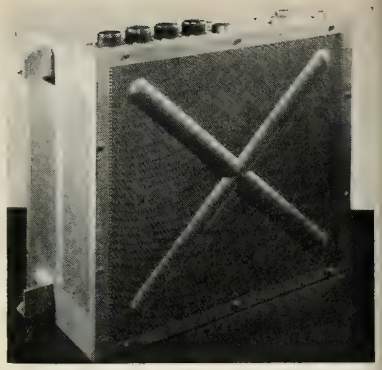
First phase of this program involves sandwich construction with silicon elements and new standard 1/10th watt resistors and will result in a reduced size package. Ultimate goal will be realized with ultra-small ceramic wafers (1x1 inch) now being developed by the Diamond Ordnance Fuze Labs in Washington.

Another element to be miniaturized and made lighter is the quartz delay line which will be replaced with a magnetostrictive delay line. Plan is to install the new delay line around the periphery of the units and use the empty center for assembly of the ceramic wafers. No time estimate was given for the ultimate package, but Arma engineers hope to have the interim unit in about two years.

Information about the stabilized platform is still in the security area, but some details of the gyros and accelerometers was released. A platform outer shell was shown at the IRE show in March and appeared to be about half the size of the *Thor* unit described in the March issue of m/r.

The stabilizing gyros are two-degree of freedom, torsion-wire suspended, fluid floated unit. The fact that each has two measuring axes means that only two gyros are necessary. As in most gyros used in inertial navigation, the spinning element is a motor, and power is brought in through the torsion wires.

Pickoff devices are mounted on the motor shell and on the outer shell. Coincidence of their positions results in a stabilization servo loop null and keeps the gyro in proper orientation. The accelerometers are non-gyroscopic, and use a unique approach whose description still falls in the security area.



CONTROL CENTRAL unit from the *Titan* guidance system. This piece of equipment, like others in system, are manufactured by Arma division of American Bosch Arma Corp.



HEART of the *Titan* guidance system—the two-degree of freedom, torsion-wire suspended, fluid-floated gyroscope. Two gyros provide the reference system for inertial measurements.

• **Super test lab**—The combined development and production test gyro laboratory where the gyros undergo final inspection and calibration prior to assembly on the platform is, in the words of an Arma engineer, "one of the largest and best equipped labs of its type on the east coast."

The dominant feature of the room is a group of six Fecker Co. sidereal tables. The stands are mounted on six foot high blocks of concrete recessed in the floor and isolated from the rest of the building to reduce any machinery-induced vibration.

Over each stand, a hole has been cut in the ceiling to align the units

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with the North Star as a reference. The stands are zeroed to within 10 seconds of arc, a seemingly impossible figure in view of their size.

In the laboratory, the gyros are mounted in heat units to simulate the operating temperature under which they must operate. The constant heat gives a constant viscosity to the high-density suspension fluid. Temperature is kept constant to within 0.004 or 0.005 degrees C.

While Arma realizes that such control is not possible in the missile, it feels that it is a definite aid in test and calibration to keep as many constants as possible to a precise figure so that more flexibility with unknowns can be gained. After mounting, the gyros are kept in the heat units all the time they are in the lab. The original heat units were spherical but Arma is now starting to use a new design that is cylindrical in shape and incorporates more advanced features to enable easier hookup for the various tests.

• **Quality control**—Another impressive feature in Arma's production setup is the quality control and environmental testing facility.

In the quality control program, a dual effort is carried on. In one phase, test-to-destruction methods are used to come up with primary selections of components.

In the other phase, large groups of components are placed in a long-range cycle to determine every possible fact about not only the units used in production, but as many competitive units as possible.

Rack after rack of semi-conductors, resistors, and capacitors go through life tests under a variety of conditions. In one test, components are assembled on a circuit board and run to failure at 85 degrees C.

The board presently undergoing this test has been operating for more than 14,500 hours, a good indication of the reliability of the system as a whole. In another test, typical circuit boards are taken to Brookhaven Atomic Laboratories and exposed to radiation in the atomic pile there.

While the transistors showed some deterioration after the irradiation, the circuit boards still operated and were well within design limits.

The environmental facilities are extensive and allow a complete environmental program to be carried on within the premises. Besides such standard facilities as hot and cold chambers, dust, sand, humidity, and salt spray simulators, installation is nearly finished on a huge walk-in Genisco rotary accelerator. The unit has a reported specimen capacity of 400 pounds and is isolated in a separate room with beefed-up floor and suspension.

• **Boss gets credit**—Much of the dynamic character of Arma's present operation can be attributed directly to Charles W. Perelle, president of American Bosch Arma for the past few years. Perelle, whose trouble-shooting in the past has run the gamut from Consolidated-Vultee to ACF-Brill Motors, has turned Arma from an engineering-oriented small company into one which operates efficiently and delivers on time, a quality not too common in the fast-growing missile business today.

Arma now builds hardware on a production line (unheard of at Arma in the past) and uncoordinated changes in a component after it reaches the production line is not tolerated.

Twelve Missile Men Killed in UAL Crash

The missile industry was hit hard by the recent collision of a United Air Lines DC-7 with an Air Force F-100F near Las Vegas. Of the 47 persons killed on the airliner, 12 were directly or indirectly active in the missile field.

The Ramo-Wooldridge Corp. of Inglewood, Calif., which coordinates the Air Force ballistic missile program, lost two top employees: Robert Hight, 36, the company's treasurer and specialist in administration and finance; and William H. Torrans, 43, mathematics specialist on ballistic missiles in R-W's Space Technology Laboratory.

Several personnel from Gilfillan Brothers, electronics manufacturing firm, were enroute to Colorado Springs, headquarters of the Air Defense Command. The group included Wendell A. Simmons, vice president of the company; and two project engineers, John A. Petrie and Ralph Charles Kean, Jr.

Three Air Force Officers flying to Omaha, headquarters of the Strategic Air Command, were attached to Ramo-Wooldridge's missile program: Maj. Robert E. Darmody, Capt. Steve Paris and Maj. Lyndell T. Highly.

Four Norton Air Force Base civilian employees also were enroute to Omaha for a SAC meeting on missiles. They were Frank R. Pebles, Charles D. Matlock, Frank A. Theobold and Harold E. Thompson.

To the talented engineer & scientist

APL OFFERS GREATER FREEDOM OF ACTIVITY

APL has responsibility for the *technical direction* of much of the guided missile program of the Navy Bureau of Ordnance. As a result staff members participate in assignments of challenging scope that range from basic research to prototype testing of weapons and weapons systems.

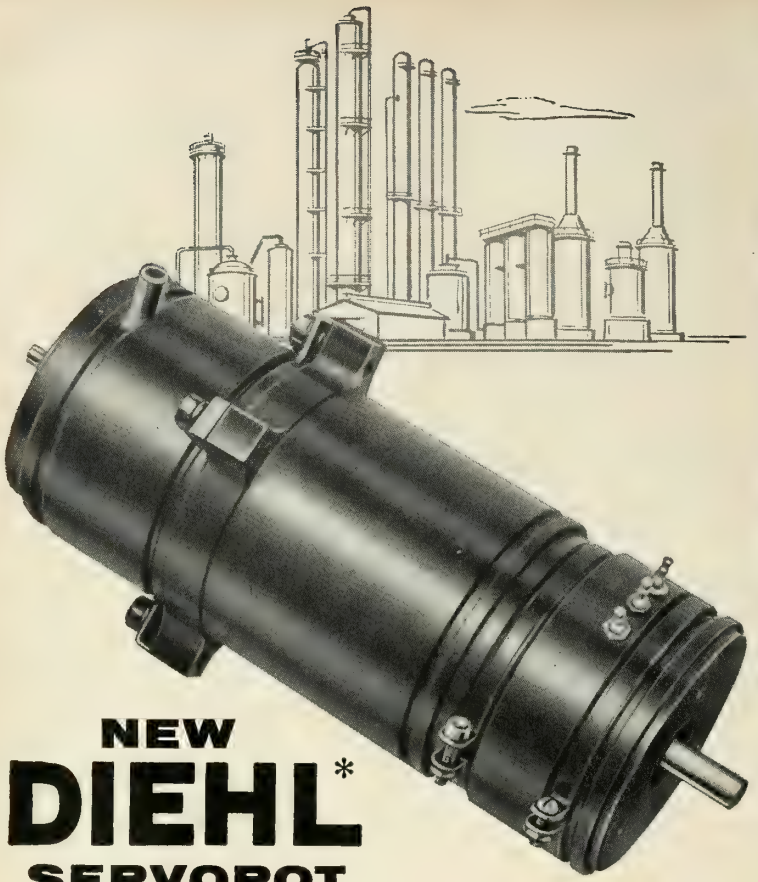
A high degree of freedom of action enables APL staff members to give free rein to their talents and ideas. Thus, professional advancement and opportunities to accept program responsibility come rapidly. Promotion is rapid, too, because of our policy of placing professional technical men at all levels of supervision.

APL's past accomplishments include: the first ramjet engine, the Aerobee high altitude rocket, the supersonic Terrier, Tartar, and Talos missiles. Presently the Laboratory is engaged in solving complex and advanced problems leading to future weapons and weapons systems vital to the national security. Interested engineers and physicists are invited to address inquiries to:

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Conceived with the idea of offering precision servo performance in a modular construction, the SERVOPOT eliminates the present burden of mounting, testing and aligning separate units.

The SERVOPOT finds wide application in balancing, positioning and computing servos. Addition of an integrally-mounted DIEHL 0.5% A.C. tachometer makes the SERVOPOT *a complete integrating servo.*

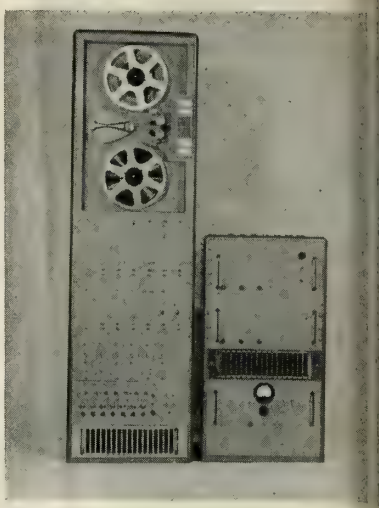
The built-in slip clutch is factory adjusted to permit servo operation into potentiometer stops without damage. Standard pots featuring 0.5% linearity can be obtained in a wide range of resistances. Single, multi-turn, and non-linear models are available,

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Consult DIEHL for further information, including integral mountings for resolvers and variacs.

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Tape Record-Reproducer Designed for Telemetry

Telectro Industries Corp., Long Island City, N.Y., has developed a tape record-reproducer unit for telemetry. Designed for maximum flexibility, it can be used for data acquisition, storage, reduction and phenomena recording.

Its modular construction provides easy access to amplifier components for inspection and service. It has a response range from DC to 120KC. Signal-to-noise ratio is better than 50DB from FM and 40 DB to AM.

There is a selection of six speeds from 1 7/8 inches per second to 120 ips. The unit can record two to 28 tracks simultaneously.

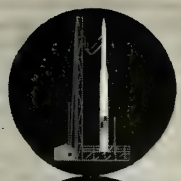
Carrier-based Missiles Pose Power Supply Task

Providing electrical power for guided missile systems aboard new Navy aircraft carriers is presenting some problems, even though present-day carriers have power systems 10 times greater than those on the first carriers built in 1930.

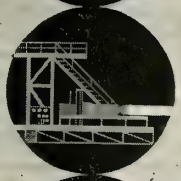
The difficulty arises, according to Navy's Bureau of Ships, from the fact that missile systems require transient-free power closely regulated in voltage and frequency, and usually at voltages and frequencies other than that of the ship's basic generating plant.

The Navy has found that certain equipment in missile guidance requires 400-cycle power, with voltage and frequency tolerances not to exceed plus or minus ½% of steady-state values, with a recovery time not exceeding 0.1 seconds.

Such a requirement has made it



MISSILE CHECK-OUT



TEST STAND OPERATION

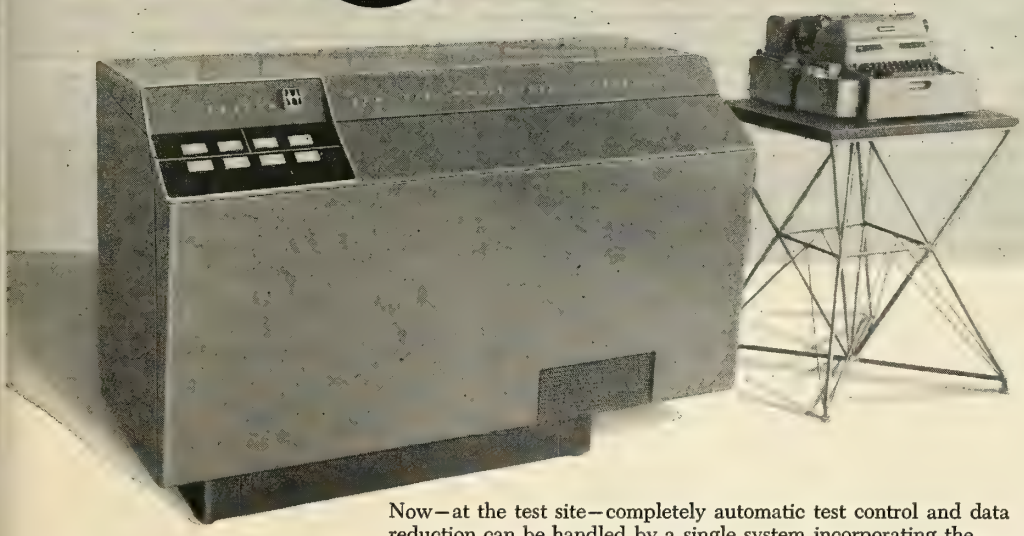


WIND TUNNEL INSTRUMENTATION



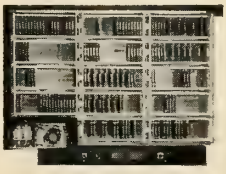
TELEMETRY DATA REDUCTION

The RW-300 is the first digital computer for test control and data reduction



Now—at the test site—completely automatic test control and data reduction can be handled by a single system incorporating the Ramo-Wooldridge RW-300 Digital Control Computer. The new RW-300 can schedule and closely control test routines, and it can collect, analyze, and record test data.

The versatile RW-300 utilizes input data as feedback to modify control actions, thus substantially shortening many test routines. In addition, the RW-300 directly logs both instrument data and complex relationships among these data. Thus, test results are available immediately. The time-consuming task of processing raw data through a separate computer, often remote from the test facility, usually can be eliminated.



For technical information on automatic test control and data reduction with the RW-300 and with special digital systems which utilize solid-state components exclusively, write: Director of Marketing, The Thompson-Ramo-Wooldridge Products Company, P.O. Box 45607, Airport Station, Los Angeles 45, California, or call OSborne 5-4601.

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Specifications tell part of the story. At Trans-Sonics, Inc., they are only the beginning. For each basic design, three volumes of evaluation tests are available containing thousands of individual data points. Essential information on performance under temperature, vibration, shock and humidity is investigated, sifted out and recorded for easy reference.

This extensive data enables the user to quickly evaluate performance under new or unexpected environmental conditions. As a result, greater design freedom is possible and valuable engineering time is saved. Write to Trans-Sonics, Inc., Dept. 9, Burlington, Massachusetts, for Pressure Potentiometer Bulletin; or if you prefer, describe your operating environment and quantitative information will be provided.

TRANS-SONICS

Precision Transducers

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necessary to isolate each load and provide a special motor-generator set for supply. These sets have a magnetic clutch to regulate frequency and specially designed voltage regulators.

With these motor-generators and other special power supplies being fed by the carrier's basic distribution system, care has to be taken in laying out the system to isolate big motor loads that would create large voltage fluctuations. Such fluctuations could be reflected in the output of the power supplies.

With development of suitable line regulators and electric speed governors, the Navy hopes that a large number of small motor-generators can be replaced with large centrally located motor-generators.

Varian Establishes Unit for Radiation Equipment

Varian Associates of Palo Alto, Calif. have formed a Radiation Division with a staff of 24 engineers and 60 technicians and machinists.

Headed by Dr. William J. McBride, Jr., who less than a year ago was named to organize systems work, the new division will design and manufacture electronic equipment, components and particle accelerators.

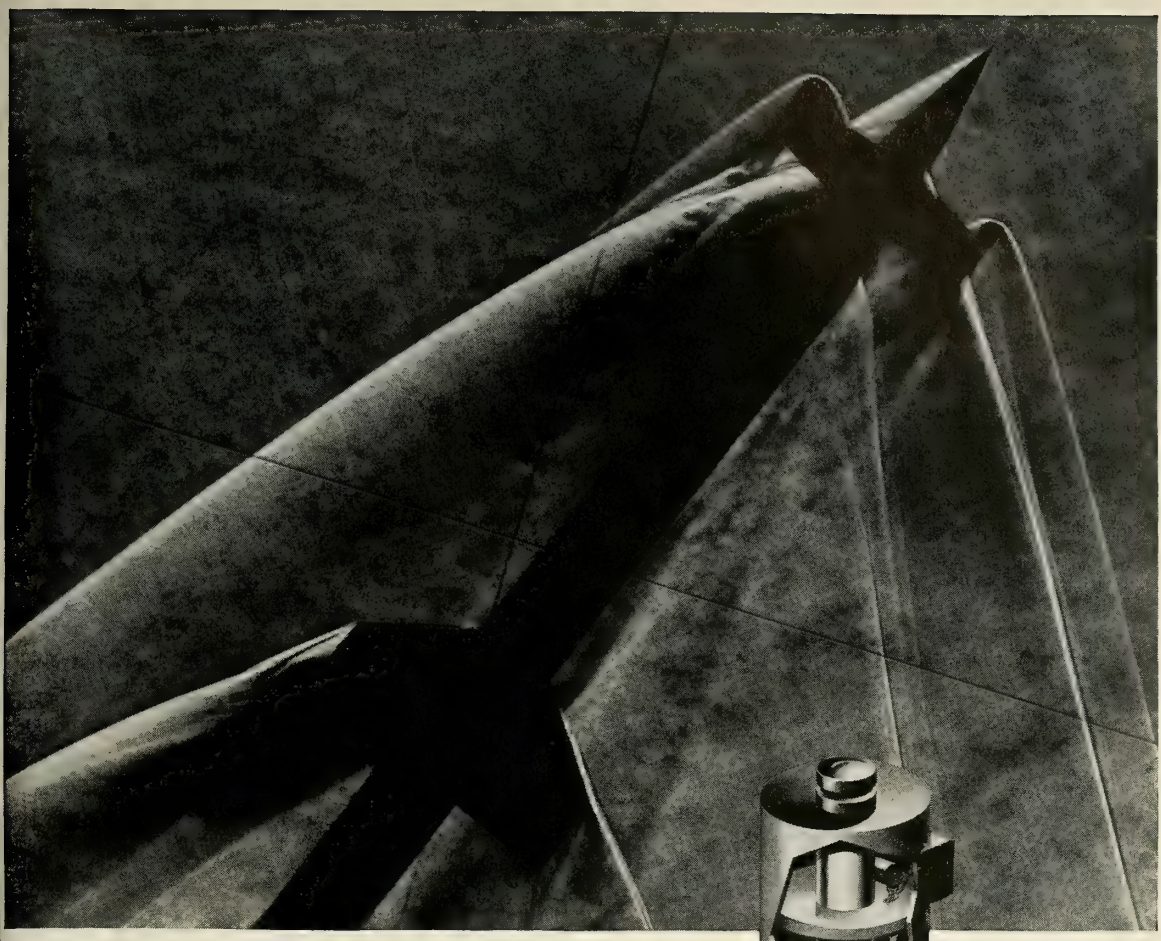
During the past nine years, Varian's development of high-power klystron amplifiers has aided in the knowledge of previously impractical techniques for radar and communication systems. Varian's new division will make equipment for these systems. Under consideration are high power pulse and c-w microwave transmitters and transmitter components; microwave components and microwave test and measurement equipment.

Compact Lycoming Unit Does Giant-Sized Job

A machine little taller than a man that duplicates and far surpasses the shock encountered by a giant missile reentering the atmosphere was recently announced by Lycoming Division, Avco Manufacturing Corporation. The unit can produce and accurately reproduce a shock of more than 100 times the force of gravity.

In operation, shock pulses are produced when the machine's carriage, dropped from a predetermined height, impacts against a molded lead pellet. Pulse shapes on an oscilloscope are controlled by the size and shape of these pellets.

Scientists tried various types of

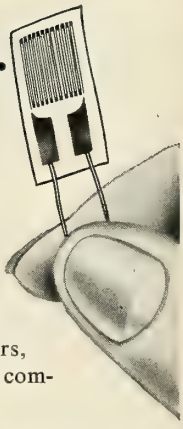


In the wind tunnel of the Naval Supersonic Laboratory at M.I.T., a missile model is subjected to speeds of several Mach numbers. B-L-H SR-4 bonded wire strain gages report longitudinal and latitudinal stresses, drag, lift, etc., with high accuracy.

Here's why B-L-H electronic transducers are preferred for force measurements

There is an easy way to measure accurately any forces involving tension or compression, torque, etc. B-L-H SR-4® electronic transducers are compact, highly responsive, and extremely durable. Stock units offer lasting accuracy of ±1/10% and repeatability of ±1/20%. With appropriate instrumentation, they can determine center of gravity, weigh loads at rest or in motion, control batch and continuous processes, and record all data required. The type and number of applications are virtually unlimited.

The heart of every B-L-H transducer is its SR-4 bonded wire strain gages. They are bonded to a metal element in the transducer and approximately 10 milliamperes is fed through them. They receive the same strains as the transducer when a force is applied. Their electrical resistance changes in linear relationship with strain. Voltage output can be calibrated directly in terms of load—or fed into any common types of instrumentation, such as dial indicators, graphic recorders, digital printers, computers, etc.



For more information on B-L-H electronic transducers—load cells, pressure cells or torque meters—ask to have a B-L-H man call on you or write to Dept. 9-E for a copy of Bulletin 4300.

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metal compounds for the pellets, and finally settled on plain plumber's lead. With this material, the machine can produce a wide variety of shock pulse shapes.

The unit accommodates specimen loads up to 40 pounds.

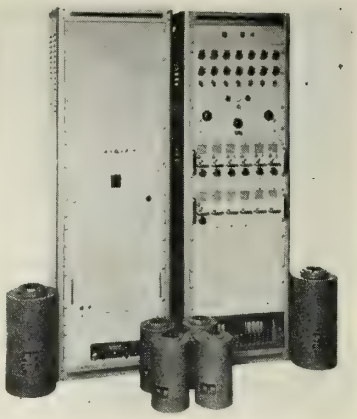
GE Has Monopropellant Power Unit Ready

General Electric's Aircraft Accessory Turbine Department has developed a monopropellant hydrazine auxiliary power unit for missiles delivering 40 horsepower for a total weight of 99 pounds, including alternator, hydraulic pump and fuel supply. GE AATD provides a number of missiles with APU equipment. It also has the contract to supply North American Aviation with the accessory power supply for the rocket-powered X-15.

New System Measures *Atlas* Weight and Thrust

A six-component thrust measuring system—to indicate and record values of missile weight, propellant weight, thrust, gimballing, motor force, and thrust mis-alignment force—has recently been displayed by the Gilmore Industries of Cleveland, Ohio.

On the *Atlas* installation, four of the load cells are mounted underneath the



missile to measure weight and thrust; the other two cells are mounted along the length of the missile to measure side-loading. When the missile is fired, the unit reports the complete thrust buildup, and if the engines are not operating properly, the launching can be stopped.

Forces measured by the system are translated into values represented by terms (a) weight and thrust, (b) pitch moment, (c) yaw moment, (d) roll moment, (e) XX axis sideload, (f) YY axis sideload.

The system compensates for the effect of sideload with respect to wind and interaction with moments. Computing equipment isolates all fixed components. A portable calibration unit, calibrated by the National Bureau of Standards, is included in the installation.

At the present time, four systems are installed at Cape Canaveral and three at Edwards AFB, California.

m/r Continues Expansion of Editorial Staff

In preparation for maintaining complete weekly coverage of the missile and rocket industry, m/r has added four editorial staff members to its Washington office. The magazine, which will become a weekly publication in July, has recently added a managing editor, several associate editors and other members, bringing the total present editorial staff to sixteen. Additional appointments will be made prior to the conversion to weekly frequency.

C. A. Hurt, assistant publisher, was formerly assistant publisher of Tooling and Production Magazine and has over eighteen years experience in the industrial sales and sales management fields.

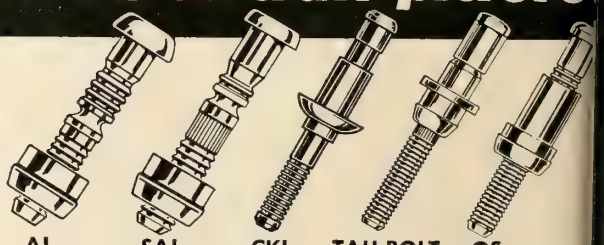
Donald E. Perry, assistant editor, was previously with The Martin Co.'s public relations department at Orlando, Fla. His duties with Martin included preparation of technical brochures and other publications. He is a former aviation editor of several Southern and Midwest newspapers.

Ellen Rosenbloom, copy editor, was formerly with United Press and the Bureau of National Affairs. She holds



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TAU BOLT Blind Bolt
OS Oversize Structural Blind Rivet

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SMALLER, LIGHTER PAM-FM SYSTEM
USES LESS POWER; TRANSMITS BETTER

A report to Engineers and Scientists from Lockheed Missile Systems — where expanding missile programs insure more promising careers

Lockheed Missile Systems engineers and scientists have developed a PAM-FM telemetering system that weighs less, is smaller, uses less power, yet operates much more efficiently than conventional systems. The new transistorized time-division multiplex system is being tested for use in monitoring future flights in connection with the Division's major missile system projects.

Lockheed holds two top U.S. defense super-priority programs: The Navy Polaris IRBM, and the Air Force reconnaissance satellite. In addition, the Q-5 target ramjet and X-7 test missile programs have been expanded. Qualified engineers and scientists who join our Division at this stage in its development are thus assured better opportunities to move ahead rapidly.

Besides **Telecommunications,** positions are open in **Radar and Data Link, Antenna, Solid State Electronics, Guidance, Flight Controls, Information Processing, Ground Support Equipment, Systems Integration, Human Engineering, Reliability Engineering, Test Planning** and **Analysis** and **Aero-Thermodynamics.** If you are qualified, your inquiry is invited. Please write Research and Development Staff, Palo Alto 7, California.

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Dr. J. W. Muehlner, Telecommunications Department Manager, left, discusses proposed packaging of the PAM-FM system with Daniel Hochman, Development Section Head.

a B.S. degree in Journalism from Syracuse University.

Thomas D. Near, editorial assistant, has just finished a three-year tour of duty with the Navy, where he served as communications and personnel officer. He holds a B.A. degree in journalism from the University of Minnesota.

New Group Set Up On Control Instrumentation

Electronic Associates, Inc. of Long Branch, N.J., has entered the automatic data processing and process control fields by forming a control instrumentation section within the company's engineering department.

Dr. Wolfgang Harries, German physicist, who has contributed to the design and development of aircraft and missile control systems, advanced radar systems, and precise generation and synthesis, is heading the group.

The group will be concerned with data logging, closed loop control systems, computer entry, and computer linkage systems. For more than a year, the company has been conducting an intensive development program on low lever amplifiers, transducer calibration units, electronic multipliers, voltage-digital converters, universal digital logic elements, and controlled format digital tape recorders.

Navy Breaks Record For Conventional Aircraft

Terming the flight an "invasion of the edge of outer space," the Navy on April 17th announced that LCDR. George C. Watkins, flying an F11-1F Super Tiger jet fighter, broke the world's altitude record for conventional aircraft.

Taking off from Edward's Air Force Base, Watkins took the jet up to 76,828 feet. Watkins said he was hoping to double the record set by Lt. Apollo Soucek, USN, in 1929. This would indicate the Navy is shooting for better than 80,000 feet with more or less conventional craft.

The Navy said additional altitude attempts would be made; and with improved weather and temperature conditions, the April 17 record might be topped.

Watkins' altitude topped the previous record of 65,000 feet set by a British Canberra in altitude tests conduted last year.

Instrument Society Sets Sept. 15-19 Convention

The 13th annual Instrument-Automation Conference and Exhibit, sponsored by the Instrument Society of America, will be held September 15-19 in Philadelphia Convention Hall.

The technical portion of the five-day program will include workshops in instrument maintenance, sales engineering, data handling, control systems and computers.

The conference will show how certain industries—aviation, chemical, petroleum, metals, nuclear, ceramics, and transportation—have made new discoveries, processes and techniques through the use of instrumentation and related techniques.

The data handling workshop will have sessions on wind tunnels, flight propulsion, process industries, power generation, oscillagraphic and photo-panel data, data transmission and storage, analog-digital converters, real-time digital computer applications and transducers.

Personnel from Moore Products Company, American Viscose Corporation, Minneapolis-Honeywell Regulator Company, Leeds and Northrup Company and Fairless Steel Works will hold the instrument maintenance clinic—always a major feature of the meeting—on September 14-15.



Need control consoles?

GENERAL ELECTRIC came to IEC

General Electric Company, Aircraft Gas Turbine Division, came to Industrial Engineering Corporation for the construction of this Master Control Console for the Engine Simulator, which was developed by General Electric for the United States Air Force.

IF your problem is functional test equipment or control panels, Industrial Engineering Corporation can supply the answer. Whether your needs call for the use of hydraulic, pneumatic, electric or electronic principles — singly or in any combination — IEC has the imagination, the know-how, the facilities to handle the job *right*, from original design to actual installation.

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FASTER WORK on missile logistic support is objective of Maj. Gen. E. W. Anderson (center), commander of San Bernardino Air Materiel Area.

Computer Setup Aids Logistic Support

Semi-automatic logistic support of ballistic missile squadrons will become a reality when an electronic data processing system goes into action at Norton AFB, San Bernardino, Calif.

Expected to be in daily use by July, the installation will be one of the largest IBM 705 data systems in the world.

Designed specifically for support of *Atlas* and *Titan* ICBMs and the *Thor* IRBM, this processing center will expedite supply actions by connecting the operating squadrons, supporting AMC bases and ballistic missile contractors in a communications network.

• **Working process**—During normal checkout of a vehicle at a launching site, some component of a missile may be found deficient. The component is then removed and returned to the supply unit of the parent squadron. In normal procedure, the squadron issues a replacement part to the site.

When the squadron's stock level of a part has been reduced by one, it will be reported to the Norton management center by an issue transaction card communicated electronically through an IBM transceiver.

Information from the squadron is applied to the computer input, and the corresponding inventory record for the part is located through master inventory records on IBM 727 magnetic tape units.

When the transaction is posted to the master record, the computer also notes the squadron's balance.

This triggers a computer-created shipping order on one of the 30-odd 727 magnetic tape machines, which then directs an AF-operated contractor storage site to ship the required quantity of the replacement part to the field squadron. This order is transmitted directly to the appropriate storage site by an IBM transceiver.

• **Final action**—Upon receipt of the shipping order, the storage site sends the parts requested and notes this action with a transceiver-sent shipping notice transaction card.

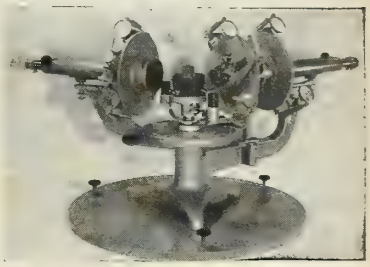
When this information is applied to the computer, it locates the master inventory record of the appropriate part and adjusts the balance remaining at the storage site.

A record of shipment is also made in an in-transit file, where the quantity is recorded on magnetic tape. An additional in-transit notice is created on magnetic tape and sent via the transceiver to inform the squadron that action has been taken.

When replacement parts are received at the squadron, it is acknowledged over the transceiver. This data is received at the management center and fed into the computer—wiping out the in-transit balance and increasing the squadron's serviceable balance on master inventory files.

The system requires about 200 full-time personnel for efficient operation. Under a lease arrangement, the 705 and associated equipment costs the AF about $60,000 per month.

New research instrument



Gaertner Ellipsometer

For the investigation and measurement of thin films by the use of elliptically polarized light.

An instrument of special interest to those working in the field of Solid State Physics.

These instruments are currently being utilized for the accurate measurement of extremely thin films by the methods of Drude, Rothen, Tronstad and others.

They are also adaptable to the study of birefringence, index of refraction and other characteristics and phenomena associated with thin films and surfaces, by the use of elliptically polarized light.

The basic instrument consists of a modified divided-circle spectrometer incorporating polarizing prisms and quarter wave plate mounted in vertical divided circles. A Babinet Soleil Compensator may also be used. Film under test is placed on the spectrometer table.

Gaertner Scientific Corporation, designers and manufacturers of precision optical and measuring instruments. 1258 Wrightwood Ave., Chicago 14, Ill. Telephone: BUckingham 1-5335.

Write for Bulletin 203-58

Gaertner
SCIENTIFIC CORPORATION
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Shock Machine to Test Ballistic Missile Parts

Lycoming Division of Avco Manufacturing Corp. will manufacture a shock machine for testing ballistic missile components, to be used particularly on the *Titan*.

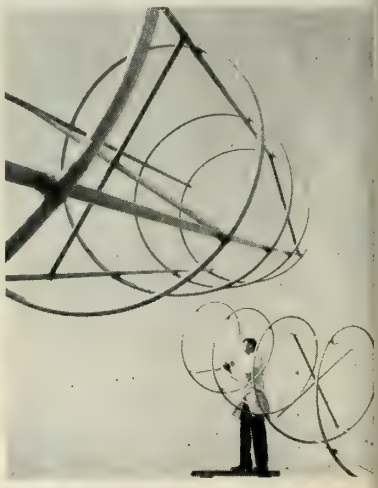
The machine was developed by the Research and Advanced Development Division of Avco, prime contractor for the nose-cone development of *Titan*. It can produce, and accurately reproduce, sawtooth-wave shock patterns of more than 100 g's over a shock response spectrum of 80 to 1000 cycles per second.

The machine provides a specified terminal-peak sawtooth pulse shape rising to 100 g's in 6 milliseconds and then dropping to zero. It also provides wave patterns including quarter- and half-sine wave shocks.

From a pre-determined drop height, the carriage hits a molded lead pellet. By controlling the size and shape of pellets, many pulse forms can be obtained.

The specimen carriage is pneumatically positioned and released for fall by a solenoid-operated mechanism. Pellets are placed on an anvil set in the 2,000 pound concrete base.

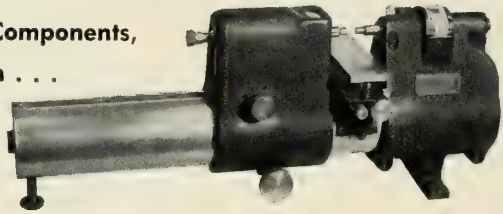
The machine accommodates specimen weights up to 40 pounds and a cross-sectional area up to 12½ inches square. It can test many items of electronic and mechanical equipment used in advanced ballistic missiles, and other equipment subject to high impact loads.



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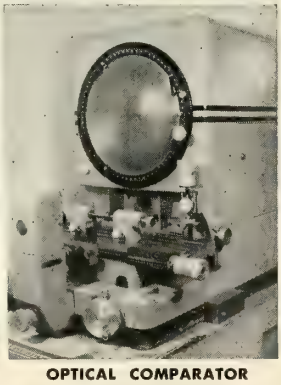
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Radar Monitors *Atlas* Ionosphere Tests

Doppler radar will be used to conduct ionospheric investigation during tests of the *Atlas* ICBM. The probing will be done by Space Technology Laboratories, a division of the Ramo-Wooldridge Corp.

Three portable trailer units containing Doppler radar will be spotted at the Cape Canaveral Air Force missile test center. Scientists will investigate the difference in frequencies recorded by the radar as the *Atlas* goes through the ionosphere.

With knowledge of the missile's speed and altitude, electron density measurements can be obtained ten times more precise than previously possible.

No special test instrumentation will be added to *Atlas* ICBMs for this research. Presence of free electrons affects guidance and radio communication. The use of low frequency waves beamed into the ionosphere and bounced back to earth are not accurate enough for missile and space vehicle studies.

New Transistor for Very High Frequency Use

Texas Instruments Inc. of Dallas has developed a new high frequency diffused base germanium transistor for commercial use. It will give high gain

Now!

Constant Damping Without Warm-up



Linear Accelerometer
Type LA-500
Shown actual size.

LINEAR ACCELEROMETERS for Aircraft and Missiles

DESCRIPTIVE DATA

- **RANGE:** Up to ±60 G full scale.
- **DAMPING RATIO:** 0.6 ±0.2 (from −65°F. to +175°F.).
- **LINEARITY:** 1% of full scale.
- **PICKOFF:** Can be provided with 2 potentiometer pickoffs (center taps optional).
- **SIZE:** 1 7/16" dia., 3 1/4" long.
- **WEIGHT:** 1 lb.

HONEYWELL LINEAR ACCELEROMETERS of the Type LA-500 Series are true linear, non-pendulous type instruments, inherently insensitive to cross-coupling accelerations. These instruments are available in a variation of ranges from ±1 G to ±60 G and can be provided with two potentiometer pickoffs. Essentially constant damping is maintained automatically throughout the entire operating range of −65°F. to +175°F. No warm-up time is required.

The combination of constant damping, high performance, small size and ruggedness makes HONEYWELL LINEAR ACCELEROMETERS of the Type 500 Series ideally suited for aircraft and missile applications where the most severe environmental conditions are encountered. Write for Bulletin LA-500, Minneapolis-Honeywell, Boston Division, Dept. 45, 40 Life Street, Boston 35, Mass.

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SERVOFRAX, developed in the infrared laboratories of Servo Corporation of America, is the arsenic trisulfide "glass" that has unmatched infrared transmission qualities . . . completely covering the spectrum of 1.0 to 12.5 microns—from the *near* to the *far infrared*.

This unequalled ability in designing and fabricating IR optical units is a natural dividend from Servo Corporation's pioneering role in *all phases* of infrared systems. In devising and manufacturing elements and other components, right on to the integration of IR sub-systems into over-all weapons systems—Servo Corporation's experience and capacities provide leadership without challenge.

For further facts on IR optical elements, write for SERVOFRAX data sheet, TDS-R-40. You will also wish information on Model 1380 Infrared Radiation Standard, in publication TDS-1380 that describes the accepted standard for testing and calibrating infrared systems and components.

For specific information about your need, consult our applications engineering staff. Please write:

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at frequencies ideal for television IFs, radio RFs, and high frequency oscillators.

Featuring a 200 megacycle (typical maximum frequency of oscillation) and a 90 megacycle (typical alpha cutoff frequency), this PNP transistor delivers 50 db gain at one megacycle and 13 db gain at 50 megacycles. In the 43 megacycle IF amplifier circuit, the transistor provides 15 db typical device gain and 20 milliwatts available unit output.

The transistor's switching time of 25 millimicroseconds in a non-saturated circuit configuration makes it applicable for high speed computer applications. It has a –30 volt breakdown voltage and 40 milliwatts total dissipation at 25°C.

New Ground-To-Ground German Rocket Developed

H. G. Mebus, former Enzian rocket engineer, has developed a new ground-to-ground rocket designed for anti-tank use. Using a hypergolic bipropellant system, the pressure-fed rocket motor has the following characteristics:

Empty Weight, lb.	13.2
Propellant Weight, lb.	8.8
Total Weight, lb.	22
Diameter, in.	4.9
Length, in.	37.4
Booth Thrust, lb. x sec.	110x3
Sustainer Thrust, lb. x sec.	44-66x20-30

With such a motor, a typical AT rocket would be:

Powerplant Weight, lb.	22
Tanks, Frame, Fuselage, lb.	6.6
Guidance, lb.	6.6
Warhead, lb.	4.4
Total Weight, lb.	39.6
Velocity (after 3 sec.), ft./sec.	262
Burnout Distance, ft.	3950-4400
Free Flight Distance, ft.	3280
Total Range, ft.	7200

Both cooled and uncooled motors are being tested. The rocket will be produced by Mebus Holz and Metallbau, OHG.

ARDC Project Space Track Conducted From Cambridge

Air Research and Development Command is conducting its project Space Track from the Air Force Cambridge Research Center at Bedford, Mass. The project, established last November, is intended to provide complete tracking of all artificial earth satellites.

Under Space Track, observational data is exchanged with the Smithsonian Astrophysical Observatory, which has primary responsibility for the optical tracking program of the IGY satellite program.

High-power beamed radars will be used to increase the number of times when orbital fixes can be obtained. Radars will be located at Millstone Hill, Laredo, and the Stanford Research Institute. Several AF contractors are reported to be developing passive infrared detectors to increase the number of satellite observations.

Bomarc Ground Support Equipment To Be Built

Food Machinery and Chemical Corporation today announced the receipt of a production contract from Boeing Airplane Company, Seattle, to build launcher-erectors and power-pack units for the Boeing *Bomarc* interceptor missile.

The number of units involved was 56; the dollar amount of the contract was $1.4-million or $25-thousand per unit.

The *Bomarc* ground support equipment will be built at FMC's Ordnance Division facilities in San Jose. This division is also producing the transporter-erector and launching base for the Air Force's IRBM *Thor* under a contract awarded in February by Douglas Aircraft Company, Inc., Santa Monica.

FMC's Ordnance Division is also producing the *Hawk* loader vehicle for Northrop Aircraft, as part of the Army's *Hawk* weapon system.

Committee on Electronic Weapons Reorganized

The Engineering Department of Electronic Industries Association recently announced reorganization of its Reliability Committee to provide a more dynamic coverage of the field of electronic weaponry and allied fields.

Renamed the Military Electronic Applications Committee; the new committee will have as chairman L. M. Clement, of Avco Manufacturing Co.

In addition to the Committee redesignation, subcommittees have been established and their new chairmen announced as follows:

Reliability—L. M. Clement.

Maintainability—Maj. Gen. F. L. Ankenbrandt of RCA.

Value Engineering—Rear Admiral R. S. Mandelkorn (USN-ret.) of Lansdale Tube.

Announcing...



Two new Titanium alloys for high temperature applications

MST 821... *the highest strength weldable sheet & bar alloy in 400—1000°F range*

MST 2.5Al-16V... *the first readily formable, heat treatable sheet alloy*

Two new alloys developed by Mallory-Sharon now extend the high temperature usefulness of titanium.

MST 821 is a weldable sheet and bar material with exceptional high temperature strength. It offers strengths equivalent to similar titanium alloys at temperatures *two hundred degrees* higher, in the 400 to 1000°F range. MST 821 is thermally stable, and has good ductility and formability.

MST 2.5Al-16V was developed in response to needs of the airframe industry for a sheet alloy which would be soft and formable in the annealed condition, and which could be heat treated, after forming, to high strengths while retaining ductility. With this material, yield strength can be as low as 50,000 psi, to permit easy fabrication, then increased to 150,000 psi by heat treatment. Age hardened sheet has good short-time hot strength—about 100,000 psi yield strength up to 800°F.

These alloys, now in limited commercial production, are further evidence of rapid advances in titanium. Use Mallory-Sharon's outstanding technical experience and service on your present requirements — or future plans—in titanium.

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Air Force Investigating New Detection System

The Air Force is trying to determine the feasibility of using electromagnetic radiation as the basis for a passive ICBM detection system that would pinpoint a long-range missile firing within two minutes of takeoff. The method would obviate the necessity of waiting until a missile reaches extreme altitudes before detection by powerful radars.

The new system, far from perfection but technically feasible, is still hamstrung by the "line-of-sight" restriction that limits the effectiveness of radar, but it shows great potential for a breakthrough in this area.

Being passive, the system eliminates the requirement for huge amounts of power needed for installations such as the 21-million-watt radar recently developed by Cornell Aeronautical Laboratory, Inc.

The Air Force has already contracted for the study of steerable beam linear arrays for a missile-borne target-seeker antenna system. This is part of a three-phase contract awarded to TRG, Inc., New York.

The other two phases of the TRG contract also involve electromagnetic radiation research, including study of the Zenneck wave, a phenomena reported to be the solution to propagation around the earth.

Excitation of the Zenneck wave results in detectable radiation, but the rate of attenuation is undisclosed. The wave can exist at almost any frequency, but most likely has practical applications at low frequencies. Excitation of the Zenneck wave is possible in several ways, but rocket exhaust characteristics are most applicable to the Air Force detection concept.

On takeoff of an ICBM, tons of chemicals emerge from the rocket exhaust in the form of ionized gases, which radiate on frequencies dependent upon the nature of the molecules and their temperature.

This is basically known as "white noise" and is detectable, but so far only in "limited ranges." There has been no elaboration on what the Air Force calls a "limited range."

The Navy recently disclosed that it has information on an "amazing" new breakthrough in global detection that was made possible by the two Soviet Sputniks.

The processes of ion emission referred to by Rear Adm. John T. Hayward are possibly connected with the similar Air Force project. In testimony

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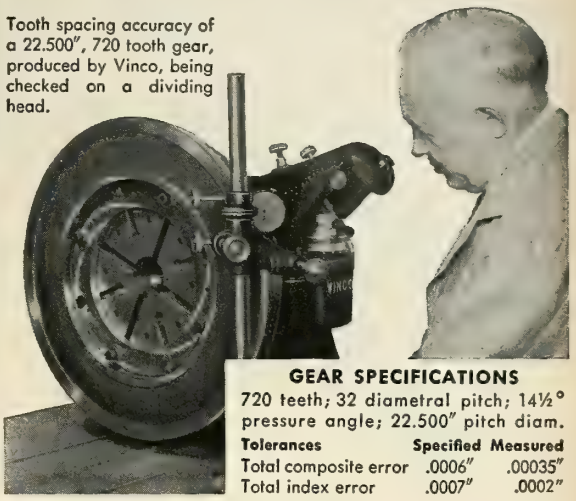
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Tooth spacing accuracy of a 22.500", 720 tooth gear, produced by Vinco, being checked on a dividing head.

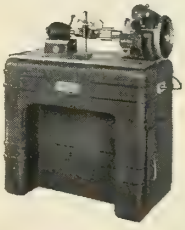


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720 teeth; 32 diametral pitch; 14½° pressure angle; 22.500" pitch diam.

Tolerances	Specified	Measured
Total composite error	.0006"	.00035"
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Model 55—38 is available either with a 20" x 40" surface plate; capacity between work centers 22", or a 20" x 72" surface plate; capacity between work centers 54". Both have a work swing of 12 7/16" dia.



The heavy duty dividing head is built to handle work with a swing up to 24 7/16" dia. Surface plate is 36" x 72". This model has the same accuracy as the standard model.

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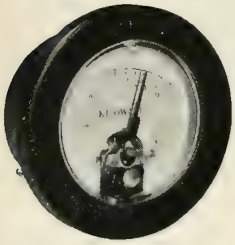
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Water tightness: submerged in tap water at a pressure of 2½" mercury for 5 minutes.

Dielectric strength: 1000 volts RMS at insulated parts.

Vibration: Survives 10-55-10 cps, .060 amplitude, 1 minute cycle, 1 hour, 3 axes.

Corrosion: Passes 50 hour salt spray (QQ-M-151a).

Contacts: Rated 100 Ma, insulation to signal coil rated 300 volts DC.

Description: Has a set of contacts in series with locking coil. Signal and locking coil, both on moving structure, lock pointer contacts positively. Resets when contact circuit is interrupted.

Assembly Products Inc.

Chesterland 88, Ohio

Booth 307, Automation Exposition
June 9-13, New York Coliseum

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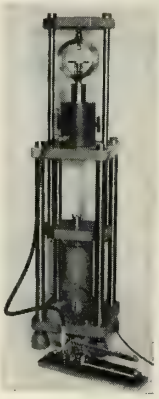
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before the House Outer Space Committee, Admiral Hayward said that objects traveling through space leave "ion trails" which are detectable.

SAC Center To Plot ICBM Trajectories

The Air Force's Strategic Air Command is building an underground missile control center at its headquarters, Offutt AFB, Nebraska, for the plotting of ICBM trajectories. The center will be an underground addition to the present SAC control center, and is expected to cost about $800,000.

The centralized operation will be manned by the Air Force's first missiles target squadron, now in training. The concentration of men and computers at the Offutt headquarters is expected to result in more economical operation and better utilization of the specialists.

A SAC spokesman indicated that work also will begin on a three-story superstructure over the target trajectory center to house an air-combat intelligence operation. An additional 60,000 square feet will be available to the SAC control center as a result of this new construction.

The new underground facility will not be designed as a heavily fortified and protected operation. However, the weight of the equipment calls for interior floor loads of 250 lbs. per square foot, as compared with a 65-lb. load for the rest of the center. This necessitates substantial construction, which will in itself afford a high degree of protection.

Telemetering Conference In Baltimore, June 2-4.

A national conference on telemetering is scheduled to be held in Baltimore on June 2-4. The conference, which will highlight discoveries made by man-made earth satellites during the International Geophysical Year, is sponsored by the American Institute of Electrical Engineers, the American Rocket Society, the Instrument Society of America, and the Institute of Aeronautical Sciences.

The IGY program will deal not only with radio and wired telemetering, but with the newer medium of transmission, sonic telemetering. Telemetering in the general fields of oceanography, astronomy, cosmic ray and rocket sounding studies also are on the agenda.

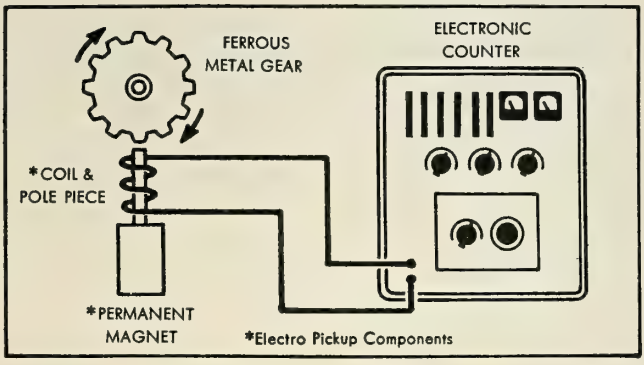
Featuring the IGY, papers will be presented by telemetry experts from the U.S., Switzerland, England, France, Italy, and possibly Russia.

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1 Accuracy of the counter (usually ± 1 digit).

2 Length of counting time.

3 Number of pulses per revolution.

Example:

60 tooth gear providing 60 pulses per revolution with a count of 1 sec. (1/60 min.) will produce an accuracy of ± 1 rpm at *any* speed. (counter reads rpm directly with this set-up). If counting time is increased to 10 sec., accuracy will be ± 1/10 rpm.

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m/e briefs

RCA is believed to be supplying the electronic payload for the Army Ballistic Missile Agency's projected reconnaissance satellite. This project reportedly has priority over any other space flight program at the Agency. Army claims the advantage of its system is a 50-mile overlap, while the Air Force proposal includes a 100-mile gap in viewing.

USAF Gen. Irvine says that there is now a "vigorous program" underway to extend the life of the AF WS-117L, (sometimes called *Pied Piper*), by developing secondary power sources including nuclear power and solar energy.

Reported limiting factor now on accelerating missile tests is instrumentation needed to permit simultaneous countdowns on more than one missile.

Army Signal Corps has awarded RCA a $5-million contract to follow up on a purported major breakthrough in miniaturization. The term is for two years, and RCA is to develop a "micromodule" concept to the point where existing electronics systems can be produced in one-eighth their present weight.

DOD has formed a standardization committee to work with guided missiles. The group will develop and recommend missile standardization plans for the assistant defense secretary for supply and logistics. Details appear in DOD directive 5126.20.

The Small Business Administration has a list of 500 military prime contractors who received $10,000 or more in government business in FY1957. Companies seeking subcontracts in experimental, developmental, and research fields may have the list upon request.

One reason for the firing delay of *Explorer* IV is the incorporation of a new experiment based on information received from *Explorer* III. One speculation is that this information would concern the science of testing electromagnetic waves

B/Gen. Beverly H. Warren says about 50% of AF's procurement dollars are going for electronics.

21st Century Electronics has a new 12,000 square-ft. lab facility in Palm Springs, Calif. for R&D into missile systems and IR proximity warning devices.

AVCO Research Laboratory has



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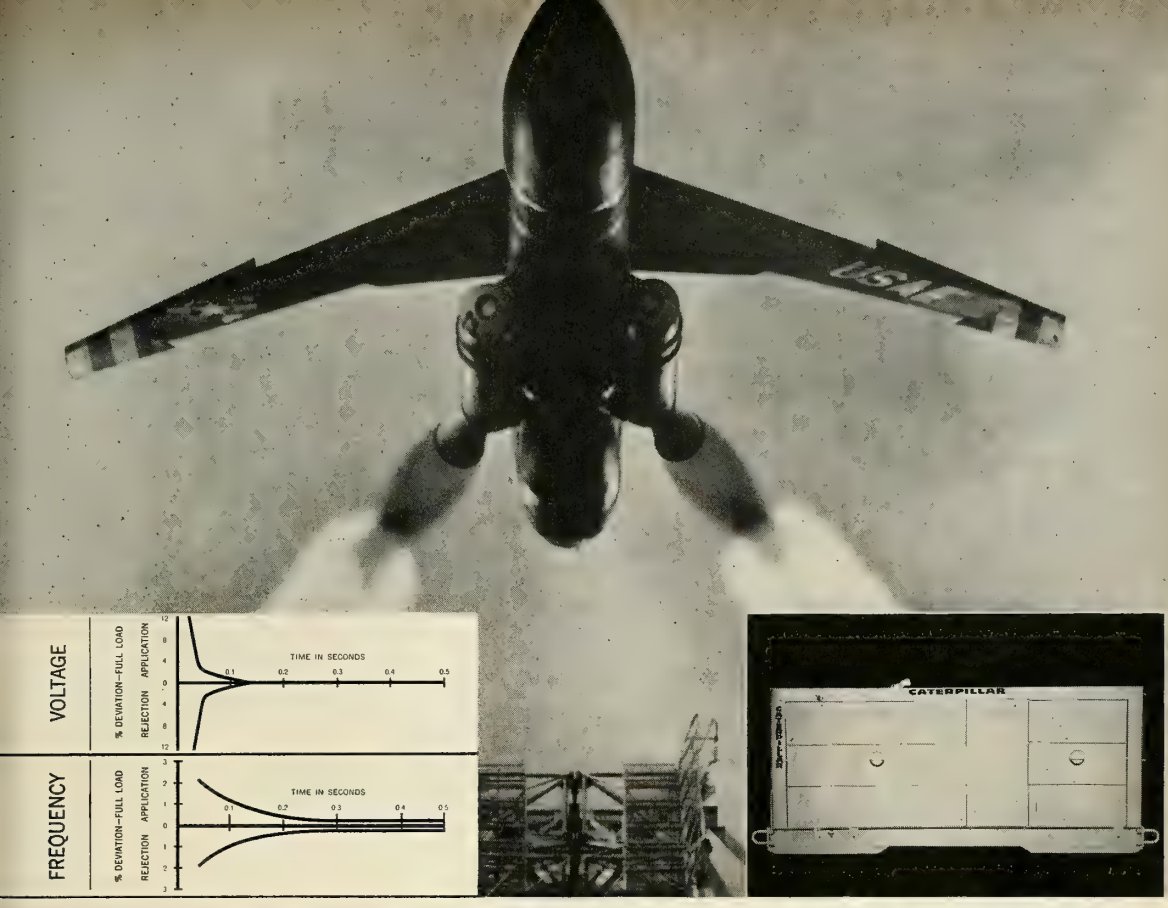
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pushed hydrogen and deuterium to velocities of 500,000 mph using experimental pulsed electro-magnetic accelerators.

Thinking of the kind prior to a breakthrough is evident in the gyro field lately. One device, the electron gyro (not yet built), would accelerate electrons to relatavistic speeds within a closed circular field. Another, the electrostatic gyro, would work by spinning a freely suspended solid sphere concentrically within another sphere, and measuring the electrostatic field displacement as the spinning sphere is moved toward the wall of the external sphere.

Lt. General Arthur G. Trudeau, Army Chief of Research and Development, will head the military delegation at a series of closed discussions on "Electronics on the Battlefield." Meetings are being held for key military and scientific leaders at Fort Huachua from April 29 to May 1. The event is the sixth in a series arranged by Army's R&D chief, dealing with overall R&D problems in the Army.



ON PYLON of the Fouga 170 Magister is Nord Aviation's *SS-11* missile. The plane carries two missiles, which can be equipped with either armor piercing or shrapnel warheads, for use in ground-to-ground, air-to-ground, and air-to-air combat. Minimum firing distance is 1,968 ft.; maximum 11,428 ft.; except when used as a target missile where the most favorable distance is 4,920 ft. Tests show that for ground firing, aircraft altitude can be between 3,280 and 4,920 ft. for firing along the center line. Lower than this, a difference of 10-20 degrees is encountered between the trajectory of the aircraft and that of the missile. Beyond 45 degrees, firing is not precise.

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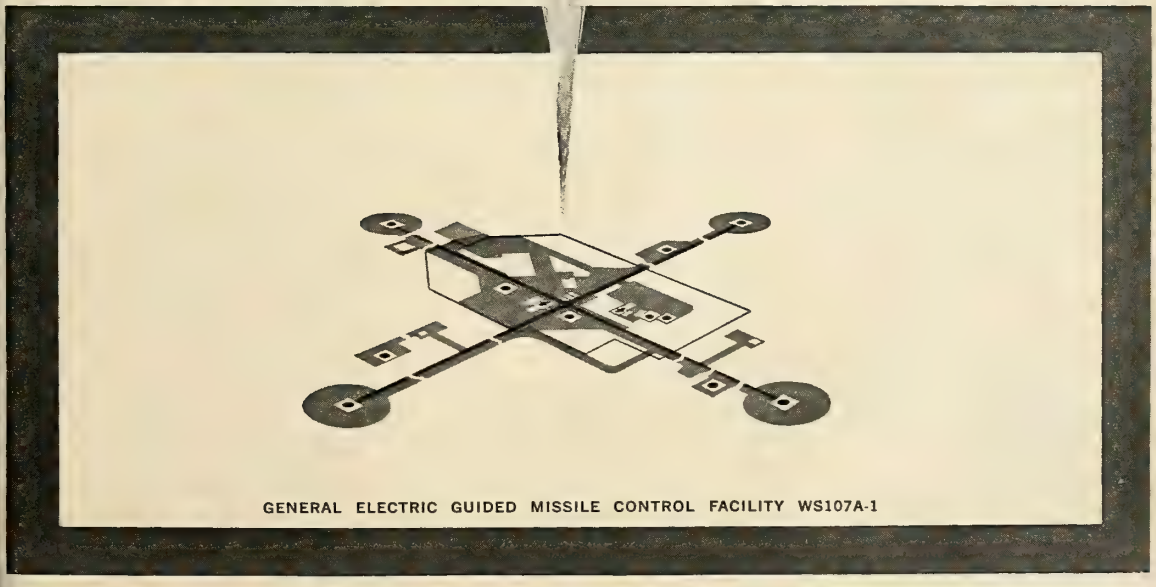
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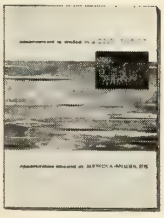
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Advertisers Index

AMP Inc. 33
Acme-Newport Steel Co., Sub. of Acme-Steel Co. 193
Adel Precision Products, Div. General Metals Corp. 68
Aero Electronics Corp. 240
Aerojet-General Corp., Sub. General Tire & Rubber Co. 5, 140, 190
Aeroquip Corp. 164
Aero Research Instrument Co., Inc. .. 240
Airborne Accessories Corp. 124
Aircraft Armaments, Inc. 175
Airdrome Parts Co. 66
Air Reduction Sales Co., Div. Air Reduction Co., Inc. 150
AiResearch Mfg. Co., Garrett Corp. . .94 & 95
Albano Co., Inc., The 134
Allegheny Ludlum Steel Corp. 43
Allied Chemical & Dye Corp., Nitrogen Div. 25
American Airlines, Inc. 132
American Brake Shoe Co. 6
American Crystoscope Makers, Inc. ... 239
American Electronics .....188 & 189
American Instruments Co., Inc. 169, 200
American Welding & Mfg. Co., The.. 46
Ampex Corp. 192
Armco Steel Corp. 129
Assembly Products, Inc. 240
Automatic & Precision Mfg. Co. 116
Autron Engineering 34
Avco Mfg. Corp., Research & Advanced Development 96
Baldwin-Lima-Hamilton Corp., Electronics & Instrumentation Div. .. 229
Standard Steel Works Div. 14
Barco Mfg. Co. 19
Morris Bean & Co. 41
Beckman & Whitley, Inc. 161
Bendix Aviation Corp., Pacific Div. 137
Scintilla Div. 20
Billings and Spencer Co., The 179
Branson Ultrasonic Corp. 238
Bridgeport Brass Company 110
Brunswick-Balke-Collender Co., The ... 48
Brush Instruments, Div. of Clevite Corp. 220
Bulova Watch Co. 136
Camco Products, Inc. 67
Cameron Iron Works, Inc. 12
Cardox Corp. 114
Caterpillar Tractor Co. 243
Chance Vought Aircraft, Inc. ..... 30 & 31
Christie Electric Corp. 194
Clary Corp. 172
Clifton Precision Products Co., Inc. . .204
Computer Control Co. 215
Connecticut Hard Rubber Co., The .. 194
Consolidated Electrodynamics Corp. 65, 117, 180, 218
Continental Aviation & Engineering Corp. 24
CONVAIR, Div. of General Dynamics Corp. 202
Cutler-Hammer, Inc. 4
Datasync, Div. of Berndt-Bach., Inc. .. 44
Delco Radio Div., General Motors Corp. 99
Diehl Mfg. Co. 226
Diversey Engineering Co. 8
Douglas Aircraft Co., Inc. 146
Dow Chemical Co., The 162
Eastern Industries, Inc. 249
Thomas A. Edison Industries, Inc., Instrument Div. 21
Electrical Engineering & Mfg. Corp. .. 135
Electro Products Laboratories, Inc. ... 241
Electronics & Instrumentation Div., Baldwin-Lima-Hamilton Corp. 229
Ellis and Watts Products, Inc. 92
Empire Devices Products Corp. 165
Ets-Hokin & Galvan 224
Eutectic Welding Alloys Corp. 186
Excelco Developments 154
Fairchild Camera & Instrument Corp. 45
Fairchild Controls 182
Flexible Tubing Corp. 119
Flexonics Corp. 138
Fluid Regulators Corp. 183
Food Machinery & Chemical Corp. . .56 & 57
Formica Corp., Sub. of Amer. Cyanamid 149
Formsprag Co. 191
Gabb Special Products, Inc. 194
Gaertner Scientific Corp. 233
General Electric Co. 72
G. M. Giannini & Co., Inc. 69
Glassco Instrument 242
Grand Central Rocket Co. 250
Grotnes Machine Works, Inc. 242
Hallamore Electronics Co., Div. The Siegler Corp. 168
Hamer Valves, Inc. 181
Haskel Engrg. & Supply Co. 148
A. W. Haydon Co., The 163
Hi-Shear Rivet Tool Co., The ....130 & 131
Johns Hopkins University 151, 225
Houdaille Industries, Inc., Buffalo Hydraulic Div. 13
Huck Mfg. Co. 230
Hudson Wire Co. 166
Hughes Aircraft Co. 97
Humphrey, Inc. 71
Hunter Mfg. Co. 133
Hydro-Aire, Inc. 160
Industrial Engineering Corp. 232
Janitrol Aircraft Div., Surface Combustion Corp. 178
Jet Propulsion Laboratory, Calif. Inst. Technology 100
Kato Engineering Co. 242
Kearfott Co., Inc. 217
Kennametal, Inc. 101
Walter Kidde & Co., Inc., Aviation Div. 18
Kollomorgen Optical Co. 118
Lebanon Steel Foundry 73
Lewis Engineering Co. 101
Librascope, Inc. 123
Linde Co., Div. of Union Carbide Corp. 195
Linear, Inc. 70
Link Aviation, Inc. ..... 10, 11 & 197
Lockheed Aircraft Corp., Missile Systems Div. 231
Lukens Steel Co. 17
MB Mfg. Co. 98
McDonnell Aircraft Corp. ..... 158 & 159
Mallory-Sharon Titanium Corp. 237
Johns Manville Corporation 153
Marion Electrical Instrument Co. 152
Marman Div., Aeroquip Corp. 157
Marquardt Aircraft Co. .....142 & 143
Martin Co., The, Denver Div. 194, 244
Mesa Plastics Co. 186
Minneapolis-Honeywell Reg. Co., Boston Div. 235
Missile Development Div., North American Aviation Div. 3
Morehouse Machine Co. 240
National Advisory Committee For Aeronautics 112
Neff Instrument Corp. 221
Nems-Clarke Co., Div. of Vitro Corp. of America 125
Norris-Thermador Corp., Norris Div. .. 60
North American Aviation, Inc. 26
Nortronics Div., Northrop Aircraft, Inc. .... 35, 36, 37, 38, 39 & 40
Nuclear Products, Erco Div., ACF Industries, Inc. 145
On Mark Couplings, Div. On Mark Engrg. Co. 175
Pacific Automation Products, Inc. .. 54 & 55
Pacific Scientific Co. 216
Pacific Valves, Inc. 144
Payne Mfg. Co. 15
Perkin Elmer Corp. 120
Propellex Chemical Corp. 238
Radio Corporation of America 187
Radioplane, Div. of Northrop Aircraft, Inc. 2
Raybestos-Manhattan, Inc. 196
Raytheon Mfg. Co. 16
Republic Steel Corp. 22
Resistoflex Corp. 58
Rheem Mfg. Co., Electronics Div. 201
Robertshaw-Fulton Controls Co., Aeronautical & Instrument Div. 32
Robertshaw-Fulton Controls Co., Fulton Sylphon Div. 29
Rocketdyne, Div., North American Aviation, Inc. 26
Safeway Heat Elements, Inc. 212
Screw Products Corp. of America 234
Servo Corporation of America 236
Shell Oil Co. 206
Snap-Tite, Inc. 42
Solar Aircraft Co. 109
Space Technology Laboratories, Div. Ramo-Wooldridge Corp. 171
Sperry Gyroscope Co., Div. of Sperry Rand Corp. 115, 199
Spinecraft, Inc. 239
Stalker Development Co. 63
Standard Steel Works Div., Baldwin-Lima-Hamilton Crop. 14
Statham Instruments, Inc. 211
Stromberg-Carlson Co., Div. General Dynamics Corp. 88
P. A. Sturtevant Co. 152
System Development Corp. 147
Taber Instrument Corp. 163
Technical Operations, Inc. 173
Telecomputing Corp. 63, 208, 209
Thiokol Chemical Corp. 53
H. I. Thompson Fiber Glass Co. 28
Thompson Products, Inc., Jet Div. 184 & 185
Thompson Ramo-Wooldridge Products, Inc. 227
Titanium Metals Corp. of America .. 214
Townsend Co., Cherry Rivet Div. 64
Trans-Sonics, Inc. 228
Union Switch & Signal, Div. Westinghouse Air Brake Co. 27
United Aircraft Products, Inc. 222
United State Gasket Co. 198
Vesto Co. 242
Vickers Inc., Div. of Sperry Rand Corp. 174
Vickers Inc., Marine & Ordnance Dept. 107
Vinco Corp. 239
Wyman-Gordon Co. 170
Yardney Electric Corp. 126

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EMPLOYMENT SECTION

Bendix Products, Guided Missiles 246
General Electric Co. 245, 247
Republic Aviation Corp. 246

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Your requests for information will be forwarded promptly to the companies concerned.

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TOMATIC TURRET. New two-posi- automatic turret, with hydraulic uation, designed to accommodate 1"x1½" tools features turret index 180° to a positive stop in either ction. Operation is entirely auto- ic; control being supplied during chining by the multicycle program- mechanism of the Mona-Matic e for which the unit is specifically ineered. Accuracy is claimed to be xcelled for an automatic turret unit his type. Monarch Machine Tool Co.

le No. 270 on Subscriber Service Card.

VO COMPONENT. Packaged unit sisting of an integral combination of two-phase instrument servomotor, r reduction, slip clutch and preci- potentiometer. Unit offers preci- servo performance in a modular struction. The Diehl Servopot is med to eliminate present burden of unting, testing and aligning separate s. Has wide application in balanc- positioning and computing servo- hanisms. Addition of an integrally nted Diehl a.c. tachometer with a % linearity makes the Servopot a plete integrating servo. Diehl Mfg.

e No. 271 on Subscriber Service Card.

ATED RATE GYRO. Subminiature ed rate gyro with high resistance hock and vibration, and having uni- damping over the entire operating e withstands 100 g's of shock and g's at 2000 cps vibration in any for even the lowest available rates. zes jewelled bearings and a pivot supporting medium for the gimbal. torsion bar used as a restraining ce is not required to absorb shock vibration. Fairchild Controls Corp. ponents Division.

s No. 272 on Subscriber Service Card.

BORER MICROSCOPE. This in- ment has been specially designed locating microscope in jig borers similar precision machine tools. cally it combines at 25x total mag- fation a fairly large field with suffi- power of observation. The eye- e contains a hairline cross and is itable for individual focusing. Stand- shanks are ½" straight, No. 2 and 3 Morse Taper. A flexible spot inator is available for independence shop lighting conditions. Micro- e is of Leitz-Wetzlar (West Ger- make and is being introduced by p-Metric Tools, Inc.

s No. 278 on Subscriber Service Card.

DROP TEST MACHINE. Model 30K, which provides shock forces in excess of 77 g's on specimens weighing up to 400 pounds, said to eliminate uncertainty of impact repeatability inherent in the conventional types and bed machines. Consists of a piston type platform on which the equipment to be tested is mounted. Platform is then subjected to a free fall into a cylinder of air pressure. Provisions are made to mount an accelerometer to the platform which supplies acceleration data to a recording device. The advantages offered by the Model 30K is "Repeatability" of acceleration waveforms and simplicity of operation to obtain shock calibrations. Aeroflex Corp.

Circle No. 279 on Subscriber Service Card.

HIGH TEMPERATURE BOBBINS. Recently developed high temperature bobbin that meets and exceeds military specifications for Class "H" insulation. The bobbin has been tested and approved to withstand temperatures up to +250°C. Specifications include material thickness from 1/32" to 1⅛" round, square, or rectangular shapes. Available for ⅜" to 1½" inside diameter coil sizes and any diameter of flange.

Circle No. 280 on Subscriber Service Card.

POTENTIOMETER. A liquid-filled potentiometer with all moving parts sealed in a bath of oil said to be one solution for degradation and performance problems experienced with precision potentiometers. Significant advantages claimed over conventional models include as many as 20-million shaft revolutions, greatly reduce noise, increased dielectric strength, prolonged shelf-life, greater heat dissipation and operation under water. Helipot Corp.

Circle No. 281 on Subscriber Service Card.

TITANIUM FORMING LUBRICANT. A titanium forming lubricant, known as T-50, has been developed by EverLube Corp. T-50 is said to solve titanium forming problems by reducing galling and permits lower die temperatures. The material can be sprayed or brushed, and air dried. After forming, T-50 is easily removed with solvent.

Circle No. 282 on Subscriber Service Card.

PORTABLE POWER SOURCE. Used to furnish preflight power for guided missiles and missile checkout trailers. The 400-cycle motor generator is synchronous motor driven and operates at 1200 RPM. Kato Engineering Co.

Circle No. 283 on Subscriber Service Card.

NAME

TITLE/POSITION

COMPANY

Product Mfg./Service Offered

ADDRESS

CITY ZONE STATE

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MISSILES AND ROCKETS

MAY, 1958

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1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125
126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150
151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175

• • Missile Literature

200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224

• • New Missile Products

225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245	246	247	248	249
250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	274
275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299

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MISSILE LITERATURE

DISCONNECT COUPLINGS. Catalog describing special quick connect/quick disconnect couplings for guided missile and aircraft use, and other applications. Most of the special couplings shown feature remote disconnection which can be by either solenoid or lanyard action, but emergency manual disconnect can also be provided. Designed with large, smooth ID passages to handle gases, hydraulic fuels, oxidizers, jet and turbine aircraft fuels and synthetic oils, valves on both couplers and nipples shut off with no leakage when disconnected. Snap-Tite, Inc.

Circle No. 203 on Subscriber Service Card.

METHANOL. Brochure on methanol, describing its varied applications, physical properties, and specifications. The brochure also provides information on handling, storage, health hazards and precautions and includes a chart showing the properties of water-methanol solutions. Reichhold Chemicals, Inc.

Circle No. 204 on Subscriber Service Card.

TRANSDUCERS AND CARRIER SYSTEMS. Carrier systems, including the remarkable new 9-oz. Instrument Translator; systems for indicating and recording torque, pressure; and transducers for high-precision measurement of linear displacement, rotation, force, flow, velocity and liquid level are described in new short form catalog. Crescent Engineering & Research Co.

Circle No. 205 on Subscriber Serivce Card.

INVESTMENT CASTINGS. Eight-page brochure featuring information on designing for investment castings. Design information covers such factors as fillets, holes, threads, wall thicknesses and tolerances.

One section is devoted to a discussion of ferrous and non-ferrous alloys which can be used for investment castings.

The literature is illustrated with photographs of nearly 100 investment cast parts.

Circle No. 206 on Subscriber Service Card.

MAIL-ORDER ELECTRONICS. A new catalog listing more than 200 components most frequently used in control equipment has been released. The catalog enables engineers to use a "Sears Roebuck" approach to purchasing electronic and electromechinical components. Servomechanisms, Inc.

Circle No. 210 on Subscriber Service Card.

TITANIUM LAB REPORTS. Three reports of research by the Battelle Memorial Institute's Titanium Metallurgical Laboratory under the titanium development program of the Department of Defense have just been released to industry through the Office of Technical Services, U.S. Department of Commerce. Another Battelle report which reviews the industrial status of high-strength aircraft steels also is available. Dept. of Commerce.

Circle No. 214 on Subscriber Service Card.

ALUMINUM ALLOYS. Three reports of Armed Forces research on aluminum alloys, one of which compares the efficiencies of vacuum and nitrogen degassing techniques to eliminate porosity, have just been released for industry use through the Office of Technical Services, U.S. Department of Commerce.

Circle No. 213 on Subscriber Service Card.

STRAIN GAGE MEASUREMENTS. Four page technical brochure "The Resistance Bridge Indicator and Its Applications" suggests many applications of this instrument which can be calibrated to indicate directly in microinches of strain, psi, pounds, ft. pounds, etc., depending upon the type of strain gage type transducer being used. Included is a simplified schematic diagram to show how the "shunting effect" across the transducer bridge is always the same regardless of the position of the follow-up potentiometer in the dual-potentiometer circuit. Another schematic illustrates how millivolt signals may be measured. The text discusses how this instrument, when supplied with an analog to digital shaft convertor, becomes the heart of a multichannel automatic digital recording system. Datran Electronics.

Circle No. 200 on Subscriber Service Card.

CATALOGS OF TECHNICAL REPORTS. Four CTR's have been published by OTS. The CTR's list all research reports available from the OTS collection in the fields of rectifiers, propellants, photogrammetry, and paper and allied products. Many of the reports listed in the catalogs are the result of research conducted for the Army, Navy, Air Force and other agencies of the U.S. Government. Others are German documents captured by the Allies during World War II. All reports listed are for sale to the public, some in printed form from OTS and others in microfilm or photocopy from the Library of Congress. Department of Commerce.

Circle No. 201 on Subscriber Service Card.

PARTS REFERENCE BOOK. A new 28 page illustrated engineering reference book on molded, extruded and die-cut parts. The book lists all types, dimensions and durometers of grommets, bumpers, bushings, suction cups, caps, cylinders, spring stock, packings, rods, roller-sleeves, crutch tips, washers, extruded parts, laboratory stoppers, gaskets and miscellaneous parts. It also lists extrusions and die cut material meeting government specifications. Miller Products Co.

Circle No. 202 on Subscriber Service Card.

SUBMINIATURE RELAYS. Over 325 subminiature relays are described in this booklet just issued. The brochure contains photographs, diagrams, relay descriptions, contact and vibration ratings and other data. Radio Corporation of America.

Circle No. 211 on Subscriber Service Card.

COBALT REFERENCE LISTS. Three new reference lists, "Aluminum-Cobalt Alloys," "Cobalt in Cast Iron," and "Cobalt in Stainless Steel" are now available.

"Aluminum-Cobalt Alloys" contains references to literature published on cobalt in aluminum alloys from 1908 to mid-1957. This four-page bibliography also lists United States and foreign patents from 1897.

"Cobalt in Cast Iron" is a one-page list of literature references and patents from 1930 to 1956.

"Cobalt in Stainless Steel" contains one page of references to literature and patents from 1941 to 1957. Included are heat-resistant and high-creep-strength austenitic steels and alloys. Cobalt Information Center, Battelle Institute.

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51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125
126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150
151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175

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250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	274
275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299

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SIMPLICITY • The solid propellant rocket engine is the simplest propulsion device yet conceived by man.

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REDLANDS, CALIFORNIA

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JUNE, 1958



missiles and rockets

INCLUDING MISSILE ELECTRONICS

MAGAZINE OF WORLD ASTRONAUTICS

This Issue: MISSILE OPTICS AND TELEMETRY



Hydro-Aire's two fresh slices of solid-state power supplies:

a DC to DC power supply (we call it the "DYNASTAT") and an AC voltage regulator. Made to be airborne—and already ordered for two advanced new missile systems—these avionic units are based on radically new circuitry with no moving parts, no tubes or other glassware, no components of questionable reliability. Naturally, they are smaller and lighter than conventional devices. They are also more efficient, longer lasting and simply foolproof. Read the descriptions. Then, let us show you how to slice them to your requirements.

AC VOLTAGE REGULATOR— Provides constant voltage output for alternating current source ±1% over ±10% changes in input voltage, and zero to 100% load changes. 95% efficient. Less than 2% waveform distortion. Can be provided for single, two or three-phase, power to 3 KVA for any frequency—60 cps to 1600 cps. Temperature range: —54 deg. C. to +125 deg. C. Response time: less than 50 milliseconds. Typical example: 450 VA, 3 phase average sensing unit that weighs 5.5 pounds and has volume of 75 cubic inches.

DC to DC POWER SUPPLY (DYNASTAT)— Output available from 5 to 15,000 volts with power output to 2 KW and voltage regulation to 0.1% over much of this range. 70% efficiency. Input 28V D.C. 10%. Temperature range: —54 deg. C. to +71 deg. C. for high power units, and to +120 deg. C. for lower powers.

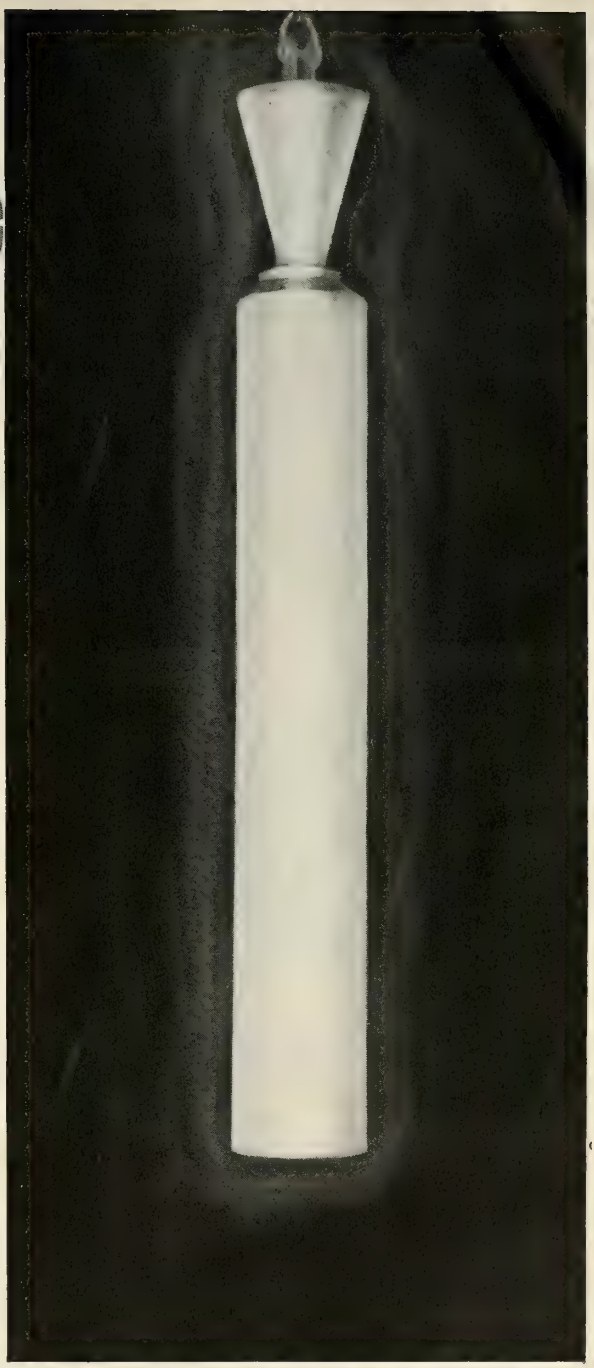
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SPAWNING GROUND

for a rocket's fury



By the time you read this message, the large rocket motor case shown here—white-hot from heat treating—will be standing ready, loaded with solid propellant, poised to rush a guided missile skyward.

Once it has been triggered into action, this rocket will generate 3500° F. heat—be called upon to withstand pressures of 1200 pounds per square inch—and the thrust from its nozzle will be equal to the power of 50 Diesel locomotives acting in unison.

Spawning such rockets calls for some real engineering—of a type not surpassed anywhere outside of Goodyear Aircraft Corporation.

Two interesting facts bear this out:

(1) Goodyear Aircraft has produced more large-size rocket cases than any other manufacturer—possibly more than all combined.

(2) Goodyear Aircraft maintains one of the largest facilities available in this country for this exacting production. And these facilities are currently completing a huge expansion.

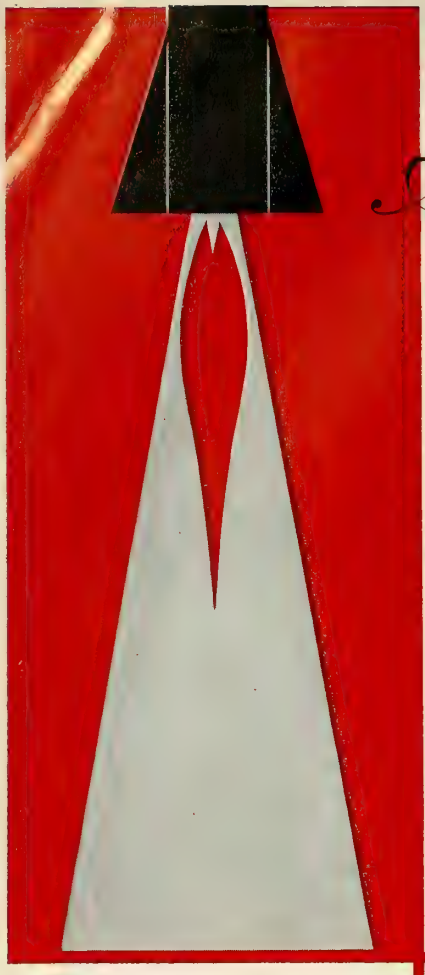
Fact is, Goodyear Aircraft developed the basic design concept which made these large lightweight rockets possible—engineering which slashed the weight of the cases up to 50%.

Summary:

Pioneer skills, vast and varied experience, complete facilities and ready availability make Goodyear Aircraft the surest thing in rockets. Write: Goodyear Aircraft Corporation, Dept. 916PR, Akron 15, Ohio.

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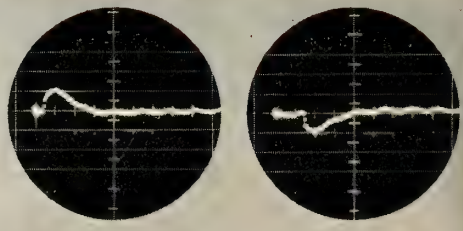
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DESIGN—When time dictates, available equipment can be adapted to your specifications. But you receive custom design, *beyond the expected*, when you need it. For example, the transistorized MAGAMP power supply (right). This unit provides a faster response time... a lower overshoot and undershoot... and remote regulation at longer distances than has ever been achieved before with this type of power supply.

DELIVERY—A contract from Douglas Aircraft for "Thor" test equipment was awarded in March 1956. A total of 100 units, comprising 30 different units, was delivered before deadline in November. On-time delivery at its best... delivery *beyond the expected.*



This transistorized MAGAMP power supply delivers a 27V to 42V output at 0 to 300 amperes, *regulated at a load up to several hundred feet away.*



The MAGAMP has a surge capacity of 400% overload for 2 seconds. Regulation at the load is 1% or better. Recovery time is less than 50 milliseconds. Overshoot and undershoot are less than 25%, with a 30% change in load. (Scale in above photos: 5V/CM and 10MS/CM.)

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Missile Equipment Section
Technical Products Division
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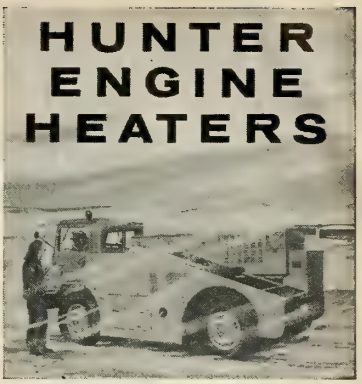
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Permanent reliability is *assured* by a manufacturer with *complete control of hose production,* as well as fitting and assembly fabrication. It is *confirmed* by use on virtually all liquid fuel and many solid fuel missiles produced to date ... *proved* by years of in-flight service on military and commercial aircraft.

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This 64-page aircraft plumbing handbook gives detailed information on Fluoroflex-T hose and hose components. It's available on request.

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this issue: Missile Optics and Telemetry

news and trends

U.S. Pushes Big Family of New Missiles
by Erik Bergaust 39

USAF Won't Support Project *Adam*
by Norman L. Baker 40

"Neat Scientific Trick": *Sputnik* III in Orbit
An m/r staff evaluation 44

M/r Editorial Viewpoint:
No Place for Snyderisms 52

Reds Build Interim Missile/Sub Fleet
by Frank McGuire 64

special features

Telemetry: Key to Missile Operation
by Raymond M. Nolan 67

Satellite "Eyes" To View Earth Weather Conditions
by William Strouse 72

Scanning the Skies: A Roundup of Tracking Systems
by Norman L. Baker 76

Small Business Status in Missile Procurement
by Donald E. Perry 80

Sandwich Construction Keeps Antennas in Shape
by Herman Holland 89

Launchers Challenge Structural Engineers 96

Automation: Computer and Social Effects 98

Profile: Dr. Fred L. Whipple
by Erica Cromley 101

Infra-Red Guidance
by Roger Esty 107

Cameras Need Stable Mounting
by R. G. Sanders 114

FBM Submarines: Ultimate Weapon
by William O. Miller 125

Cameras: Top Testing Tool for Missiles
by Peer Fossen 134

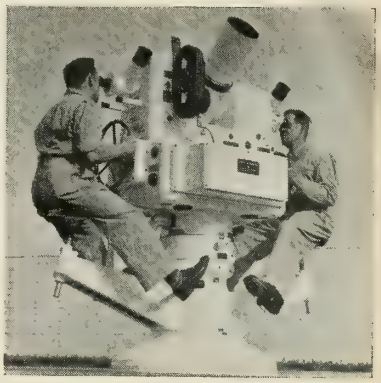
Atlas Calls for New Shock Techniques 140

Automatic Calibrator Speeds Missiles
by Donald E. Perry 144

next issue:

The first of m/r's weekly issues—the News and Business edition—will be in the hands of subscribers by July 7. On July 14, readers will receive the first Engineering and Electronics edition.

cover picture:



The missile and space era has developed many new applications for optical precision instruments. In addition to improving existing designs, the optical industry, both here and abroad, has created a series of ultra-precision instruments. These instruments will aid the U.S. missile industry and military in their efforts to evaluate and improve the performance of ballistic missiles and satellite-carrying vehicles. A typical example is the EOTS (Electronic Optical Tracking System) cine-theodolite shown in the above photograph. Designed and manufactured by Contraves AG of Zurich, Switzerland, many units are now installed in military tracking stations in the U.S., with several more scheduled for future installation. (See p. 122).

columns

Missile Business 30
West Coast Industry ... 32
Space Age 34
Washington Trends 37
Soviet Affairs 159
Propulsion Engineering . 160
World Astronautics 163
Space Medicine 181

departments

Editorial 9
When and Where 10
Letters 14
Contract Report 21
Moscow Briefs 152
Missile People 165
Book Reviews 177
Missile Miscellany 183
Missile Products 185
Missile Electronics News 200



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The Fourth Element

It took this country thirty-five years to get an Air Force. Since the first World War, air defense was a stepchild of the U.S. Army—an almost unbelievable approach for the most advanced country in the world. In many ways this concept cost the United States billions of dollars in unnecessary expenditures. It tied American aviation to strictly earthbound methods and principles and often to very restricted and inhibited thinking, research and development.

Are we about to repeat this shortsighted approach to building our Space Force? Tying spacepower to airpower, or to land or seapower, cannot be justified because of any historic, industrial or military reason. We have the spectacle of all three services scrambling to take over the space power capability, while simultaneously—in many quarters—pooh-poohing it. Development of a true space capability, in ballistic missiles, satellites, and beyond, has been delayed years by earthbound, seabound, or airbound thinking. This thinking has made the most common word for satellite a Russian one. It has made us come out second best in the race for long-range ballistic missiles. Now, many of the foremost foot draggers are emerging as space champions in shining armor—we wonder for how long.

The fact is, however, that a new concept and a new industry, the space systems industry, is rapidly arising, and it appears that government must organize in the same way. We must and will have a U.S. Space Force. The only question is whether we are going to have to fight the battle for thirty five years, as did the airpower advocates, or can we be a little wiser and more forward looking this time and do it now? Do the Air Force advocates remember what it took to set up a separate Air Force?

Of this we are morally certain: the squabbling over this new infant will not cease, nor will the baby grow to healthy maturity until he is recognized as a new individual and not regarded merely an excrescence on an existing adult.

Traditionally we have classified our services according to the medium in or on which they operate, although it took many years for airpower to gain co-equal status with land and seapower. We are repeating the same error that hogtied airpower for many years—and some of the greatest airpower proponents are aiding and abetting this action—to their everlasting discredit. To argue that spacepower is merely an extension of airpower is to ignore the facts.

Likewise, to force a shotgun wedding between the National Advisory Committee for Aeronautics and a National Space Flight Agency is, in our opinion, an even greater error than to perpetuate the existing division of space weapons among the three traditional services.

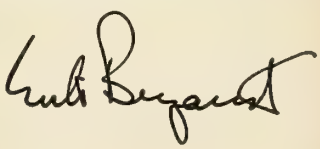
The NACA is an excellent organization that has made invaluable contributions to the growth of American aviation, but only a minor fraction of its facilities have any significant utility in advancing the new science of astronautics.

The most likely outcome of a merger of missions would be to place *aeronautical* experts in charge of *astronautical* development. Seniority considerations would make such an outcome almost inevitable. The more experienced people are more experienced in air science, not space science, since the latter is in itself young. To expect that the appropriation pie would then be cut to give *astronautics* a fair share, when *aeronautical* people are doing the cutting, would be naive in the extreme. It would be just as naive to expect men whose entire careers have been spent studying the problems of aeronautics, to take bold action in the area of astronautics.

True, to some extent the NACA can contribute to the advancement of astronautics, but so can many other research organizations, civilian and military. This know-how must be pooled under a separate, co-equal civil space agency.

The men of the air age should not presume omniscience in this new area they have so recently embraced. Nor do the middle bracket air scientists have to assume the cloth of spacemen to insure their livelihood. We shall still need better aircraft for many years to come.

There are many things that need to be learned and done in the area of non-military astronautics. Let us place direction and execution of this work in the hands of experienced space scientists, unhampered by inbred aeronautical bias.





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JUNE

IAS, AIEE, ISA, National Telemetering Conference, Lord Baltimore Hotel, Baltimore, Md., June 2-4.

First National Guided Missile Industry Conference, Mayflower Hotel, Wash., D.C., June 4-6 (Robert H. Goddard Memorial Dinner, June 6).

Armed Forces Communication and Electronics Assn. Convention, Sheraton-Carlton Hotel, Wash., D.C., June 4-6.

IRE Second National Symposium on Production Techniques, Hotel New Yorker, N.Y., N.Y., June 5-6.

American Rocket Society, Semi-annual Meeting, Hotel Statler, Los Angeles, Calif., June 8-11.

Fourth International Automation Exposition and Congress, New York Coliseum, June 9-13.

Military Electronics, Second National Convention, Wash., D.C., June 16-18.

American Institute of Chemical Engineers, 50th Anniversary Meeting, Phila., Pa., June 22-27.

Special Summer Program on Random Vibration, an introduction to the vibration problem in missiles, and jet aircraft, Massachusetts Institute of Technology, Cambridge, Mass., June 23-July 3.

AIEE, Air Transportation Conference, Statler Hotel, Buffalo, N.Y., June 25-27.

Industry Missile & Space Age Conference, Aero Club of Michigan, Hotel Statler, Detroit, Mich., June 30-July 1.

JULY

IAS National Summer Meeting, Ambassador Hotel, Los Angeles, Calif., July 8-11.

NACA Ames Aeronautical Laboratory, Triennial Inspection, Moffett Field, Calif., July 14-15.

Fifth Annual Symposium on Computers and Data Processing, Albany Hotel, Denver, Colo., July 24-25.

Third Annual Exhiborama, Society of Photographic Instrumentation Engineers, Second Annual Symposium, Statler Hotel, Los Angeles, Calif., July 29-31.

AUGUST

AIEE, IRE, NBS, Conference on Electronic Standards and Measurements, National Bureau of Standards Boulder Laboratories, Boulder, Colo., Aug. 13-15.

ASME, A. I. Ch. E. Conference, Northwestern University, Evanston, Ill., Aug. 18-21.

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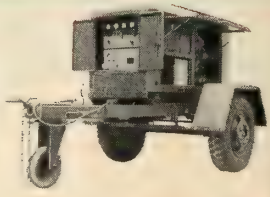
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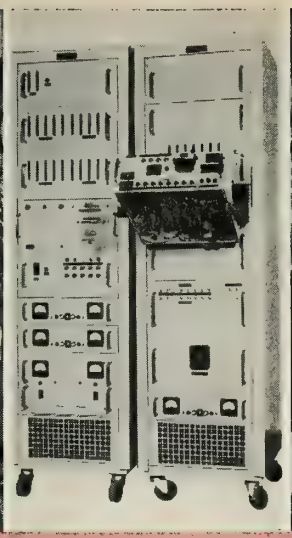
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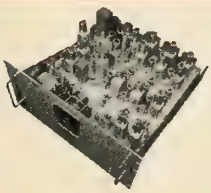
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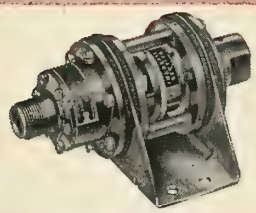
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letters

Free Radical System

To the Editor:

In reference to the article "How Good Are Free Radicals?" (m/r March, p. 78), I should like to mention several discrepancies.

The specific impulse (sec) of H is listed as 2160, whereas it should be about 1400, shifting, or about 1200, frozen.

The figures given for He* are incorrect (Table III). These figures are actually for %'s He* *one-tenth* of those shown. In other words, He* has a specific impulse (sec) of about 800 at 10%, rather than 100% He* in He. 100% He* will have a specific impulse of over 2,000 $\frac{\text{lb. (F)-sec.}}{\text{lb. (M)}}$

Hence the performance potential of He* is much greater than your figures would indicate.

Dr. G. C. Szego
Supervisor-Thermodynamics
Applied Rocket Research,
Rocket Engine Section
General Electric Co.
Cincinnati 15, Ohio

In answer to the specific impulse of H, the data was obtained from Aerojet and represents a theoretical value (limiting.) You are correct that in Table III, the helium column, should have read 10% mol He in He. This means the concentration at night would be 0.1 of stated value. This is for He only—Ed.*

Tantalum Availability

To the Editor:

In the article "Materials Build a New Technology" (m/r March, p. 91), there are some misstatements which should be corrected:

The author (W. C. Rous, Jr.) shows the availability of tantalum as "Gen. avail. limited quantity" (current status), "Unpredictable; critical material" (probable future status), "Performance good, avail. unpredictable" (potential development).

Mr. Rous also states that "Tungsten, tantalum and rhenium all have very high density and high temperature resistance. They are very scarce, are difficult to produce in specific shapes and their future development is unpredictable."

Later in the article, however, Mr. Rous appears to contradict himself when he states that "molybdenum, tantalum, tungsten and columbium (niobium) are the most feasible metals for development as elevated structural materials on the basis of melting point, availability, price and vapor pressure."

What we object to specifically is the implication that tantalum is "very scarce", that its availability is "limited" or "unpredictable."

While it is true that during 1956-57, the demand for certain forms of tantalum (notably the materials used in tantalum capacitors) exceeded our production capacity, we do not know of a single project which has been delayed or abandoned because of a lack of tantalum. We have just completed a plant in Muskogee, Oklahoma, which will add 50% to our tantalum-producing capacity.

According to a recent news article, "Figures on tantalum refining are guarded, but refinery output has probably more than doubled in the past six months. The major supplier has upped his capacity by 50%. Another refiner reportedly is able to produce as much as the total supply of a year ago. And, it is learned, there are four new sources."

Allan L. Percy
Director of Public Relations
Fansteel Metallurgical Corp.
Chicago, Ill.

The information regarding the availability of tantalum was gathered in the fall of '56, about the time (as Mr. Percy verifies) demand for certain forms of tantalum was temporarily exceeding production. This implied that the current supply was "generally available in limited quantity", and that if a national emergency arose at the same time as tantalum sheet were desired in advance type aircraft, the future supply would be "unpredictable."

Referring to tungsten, tantalum and rhenium characteristics, a misleading statement would have been eliminated if the following had been stated:

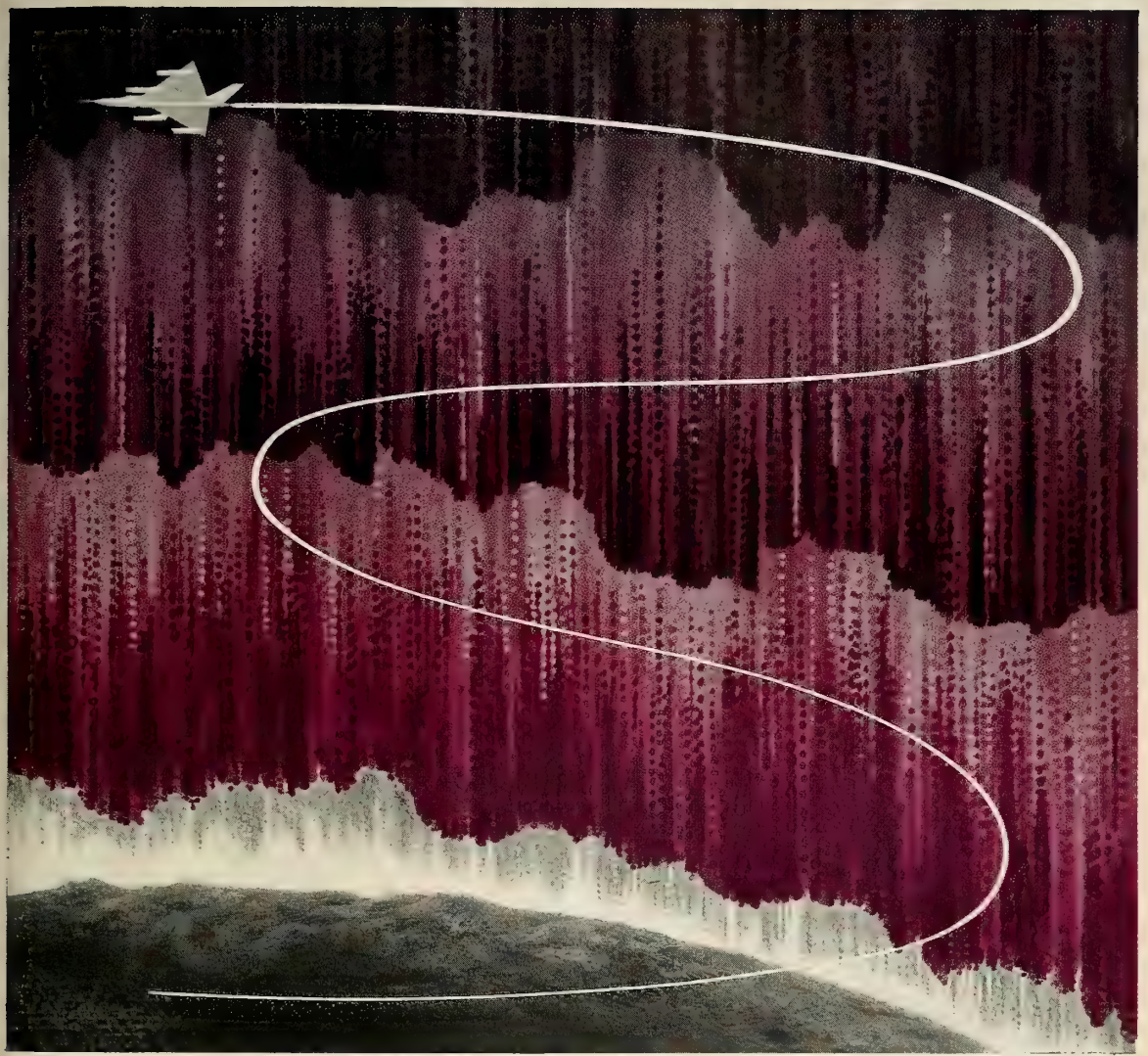
"Rhenium is very scarce. Tungsten, and to a lesser degree, tantalum, is difficult to produce in large sheets. Development of sufficient sized sheet production by such methods as compacting and densifying fiber metals is a possibility. However, future airframe use on this basis is unpredictable."

I believe we all agree to the statement regarding the status of molybdenum, tantalum, tungsten, and columbium (niobium).—W. C. Rous, Jr.

Brass Indifferent?

To the Editor:

I recently heard a newscast that the Navy had successfully launched a *Subroc* missile, and I tried to find out more



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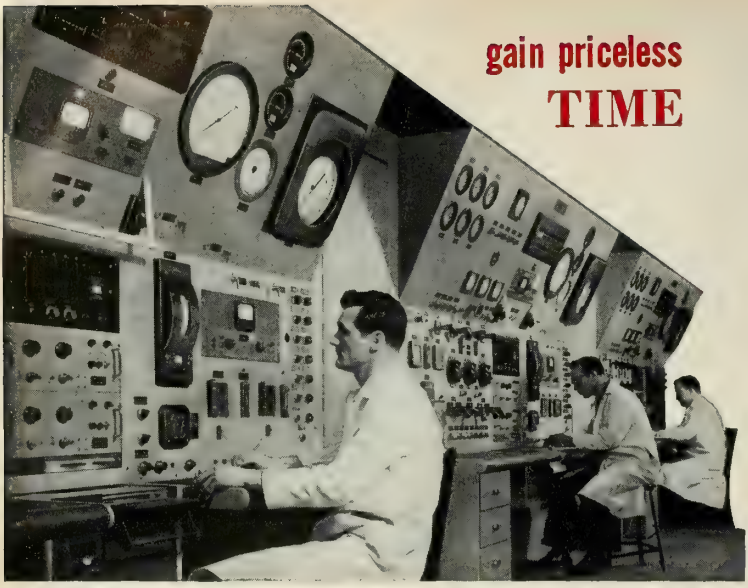
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. . . letters

information on the subject. The local Navy office recommended reading "quite an article" on *Subroc* in your April issue. ("Navy Pushing New Underwater *Subroc* Missile", p. 37.)

I also want to commend you on the editorial "We're Falling Behind Again" (m/r April, p. 9).

It's pretty disconcerting to talk to people, presumably knowledgeable, day after day and encounter little other than indifference or stupidity on the subject of nuclear propulsion of missiles. In talking to high brass, some savvy on the subject is detectable, but mostly none. If this is the official attitude of that branch of the Armed Forces charged with "massive retaliation", no wonder Pentagon re-organization is in order.

Giles S. Crosse
17 Mann Avenue
Fairborn, Ohio

Glad to have such agreement with our viewpoint. Our opinions are strong on this matter, too . . . Ed.

Titanium Strength

To the Editor:

In the excellent "1958 Missile Materials Review" (m/r March, p. 69), we feel that Table III gave a rather unfortunate comparison between titanium and other materials of construction.

Titanium alloy strength is listed in the table as 90,000 psi, which would be approximately correct for unalloyed titanium used today by the airframe industry. However, some of the alloys in use by the airframe and jet engine people range in strength from 120-160,000 psi, which would make titanium appear considerably better.

Actually, the alloys which we are recommending for missile applications would be heat treated to a strength of 190,000 psi. In some cases where ductility is not a major factor, we believe these alloys can be successfully heat treated to 205,000 psi ultimate tensile.

Excepting the more conservative figure of 190,000 psi, this would change the strength density ratio to 1,170,000. As you can see, this is considerably better than the present glass plastic values and very close to the value given for future glass plastics.

R. C. Durstein
Assistant Product Manager
Crucible Steel Co. of America
Midland Works, Titanium Div.
Midland, Pa.

Thanks for the clarification. Other readers will also welcome it . . . Ed.

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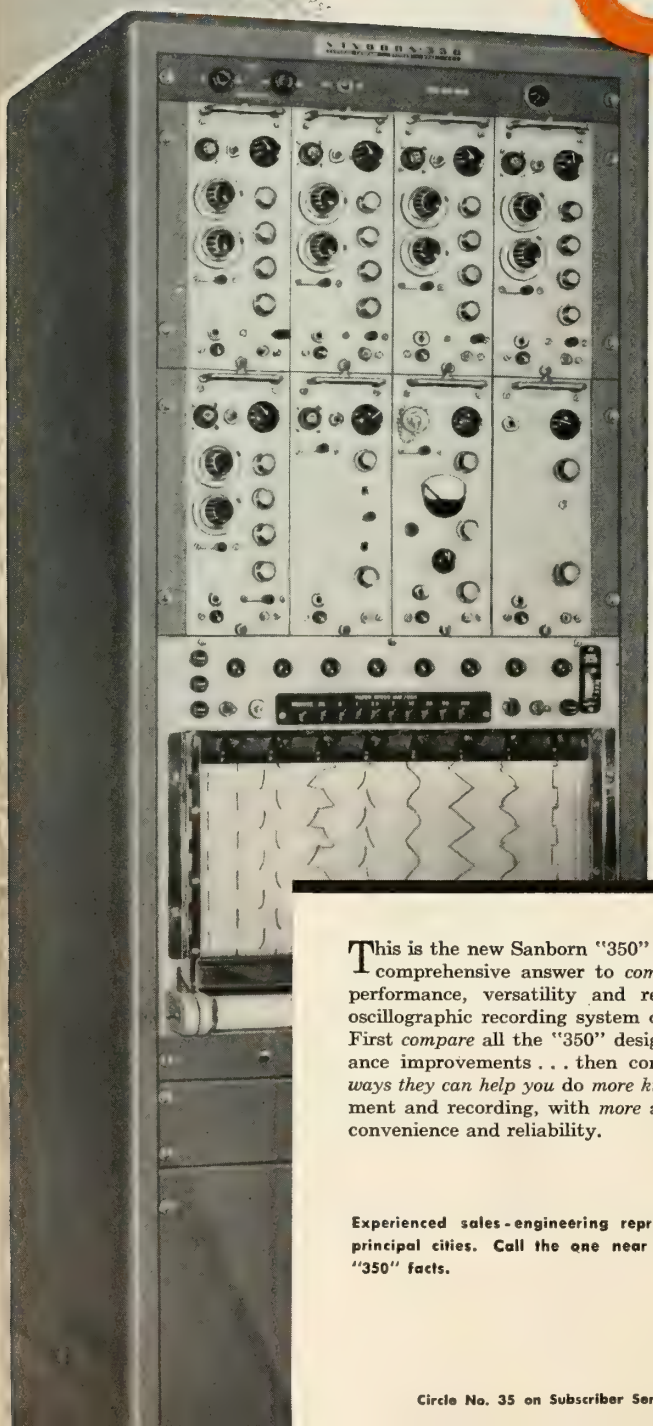
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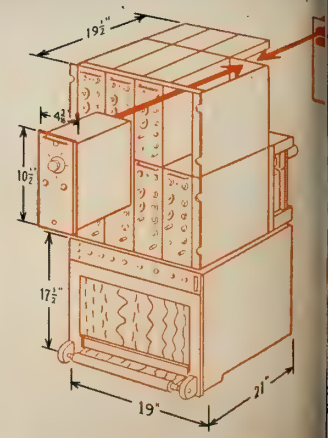
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Integral, tube-free package includes eight power amplifiers and power supply, which use power transistors and solid state rectifiers. Operates on 115 volts, 60 cycles. Simple paper loading from front. Individual stylus heat controls, chart speed pushbuttons, motor switch, timer-marker switch, fuses, paper footage indicator all on front panel. Connectors for input signals, output monitoring (±1 volt with respect to ground from 2.5 ohm source) and complete remote control provided at rear.

VELOCITY FEEDBACK DAMPING

True damping by velocity signal from separate winding over galvanometer driving coil. Damping control accessible from front of Recorder for easy adjustment.

(ALL DATA SUBJECT TO CHANGE WITHOUT NOTICE)

GALVANOMETER NATURAL FREQUENCY 55 CPS

Higher natural frequency provides higher over-all system frequency response.

INKLESS RECORDINGS IN TRUE RECTANGULAR COORDINATES

Heated stylus creates sharp, smudge-proof trace on plastic coated Permapaper. Chart channel width 1 7/16" (approx. 4 cm), ruled in 50 div. of 1/32" each.

RECORDER-AMPLIFIER UNIT HAS 0.1 VOLT/CHART DIV. SENSITIVITY

Can be used alone, when preamplification is not needed. (Three complete 8-channel Recorder-amplifier-power supply units can be mounted in one cabinet.)

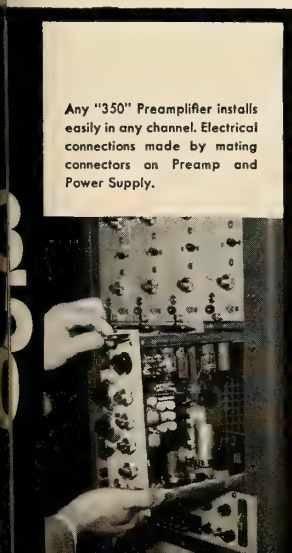
ELECTRICAL PUSHBUTTON CHART SPEED CONTROL, WITH PROVISION FOR REMOTE CONTROL

Any of nine speeds (0.25, 0.5, 1.0, 2.5, 5, 10, 25, 50, 100 mm/sec.) instantly selectable by pushbutton. Plastic strip for channel identification markings.

QUALITY COMPONENTS USED THROUGHOUT

JAN components used wherever practicable; for example, note in the photos hermetically sealed MIL-T-27 power transformers, MIL-approved electrolytic condensers in all power supplies, ruggedized premium-type tubes in Preamp power supplies, etc.

SANBORN COMPANY
INDUSTRIAL DIVISION
175 WYMAN STREET, WALTHAM 54, MASS.



Any "350" Preamplifier installs easily in any channel. Electrical connections made by mating connectors on Preamp and Power Supply.



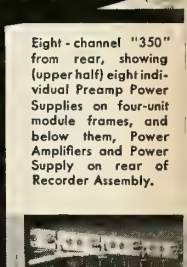
Quick, simple paper loading is done from front; hinged viewing window is removable. About 8" of record visible. All controls on front panel.



Any of nine chart speeds can be instantly selected by pushbutton. Remote control of all functions provided by connectors at rear.



Recorder back plate holds eight plug-in Power Amplifier modules (one shown unplugged in photo), four on either side of Power Supply section. Entire back plate removable for servicing.

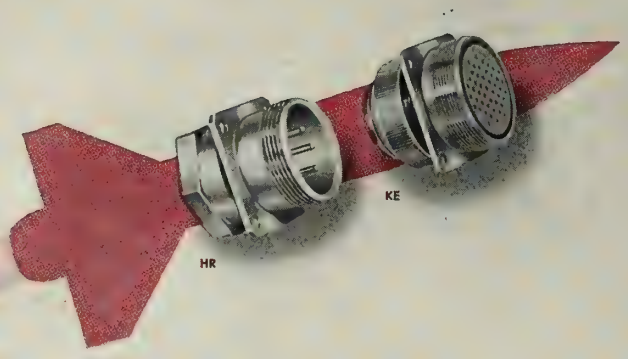


Eight-channel "350" from rear, showing (upper half) eight individual Preamp Power Supplies on four-unit module frames, and below them, Power Amplifiers and Power Supply on rear of Recorder Assembly.



NEW

CANNON PLUGS



For greatest reliability in the hot spots

NEW **HR** SERIES

1000°F continuous duty type

The most advanced design to protect against extreme heat, nuclear radiation and moisture formation. Moistureproofing on these connectors is accomplished by means of ball cone seals on mating surfaces. Available in production quantities in wide range of MS-type shell styles and sizes. Two to 24 contacts per shell. Wide variety of insert patterns that mate with standard MS types. A modification of the HR series, rated at 650°F continuous duty, is also available.

Write today for Technical Bulletin T-111

NEW **KE** SERIES

Moisture-resistant firewall type

First plug to satisfy both high-temperature requirements for fireproof Class MS-K connector and vibration-proof, moisture-proof requirements of MS-E Class. Meets 2000° flame test specified in MIL-C-5015—stands up under 400°F continuous operation. Fluorinated silicone seals for moisture-proofing improve resistance to oil and skydrol hydraulic fluid. Two basic shell types for conduit and wire bundles. Wide variety of insert arrangements and shell sizes in long and short types.

Write today for Technical Bulletin T-98

27,000 KINDS TO CHOOSE FROM!

Call on Cannon for *all* your plug needs. If we don't have what you want, we'll make it for you—whether you need one or a million. We're ready to help you at any stage—from basic design to volume production—with the largest facilities in the world for plug research, development and manufacturing. Write us today about your problem. Please refer to Dept. 438

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CANNON ELECTRIC COMPANY

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contract report

Trends

The Renegotiation Act will be renewed. At this writing, that's about all that's clear in this situation. There's quite a fight brewing on Capitol Hill as to exactly what form the renewal will take. But you can count on some easing of the regulations governing allowable profits earned through the "efficiency and economy" of the contractor. Increased profits on Defense business for the purpose of supporting additional research, development and facilities will not be allowed. The Government, instead, will probably hike the degree to which it directly supports these activities.

Continued jiggery-pokery with contract payments seems inevitable as the Government resorts to expenditure slowdowns in order to keep the budget deficit within preset limits. There's also a danger of another contract cutback in order to preclude expenditures reaching too high a level. Neither retarded payments nor ceilings on the rate of contracting should reach the extreme degree of last fall.

As an aid to distressed labor areas, new clauses are now being written into government contracts. These set an order of preference for placing subcontracts, as follows: (1) Small business concerns in labor surplus areas; other concerns in labor surplus areas; (2) small business concerns not in labor surplus areas.

Another policy decision affecting contracts is designed to equalize business by instructing procurement offices that, most things being equal, the contract will go to the company that has the smallest backlog.

The 5% budget transfer authority requested by the Department of Defense refers to authority to transfer funds up to 5% within each major budget category—not authority to transfer 5% of the total military budget in one lump sum, according to Assistant Defense Secretary W. J. McNeil.

Anyone with Thor or Jupiter contracts faces an uncertain future. The actual final decision as to how many of each will be produced is yet to be made. One proposal that's favored would hike *Thor* orders and cut back *Jupiter*, perhaps to limit of AMBA's Huntsville production capacity. This would, in effect, peg *Thor* as the weapon; *Jupiter*, for space flight work.

The foreign missile market has been pegged at $288 million—at least that's the portion of the foreign aid budget in 1959 allocated to "missiles and modernization of aircraft". Actually, the total foreign market for U.S. missiles will be somewhat larger, since some countries are planning to pay for their own *Nikes* and *Lacrosses*.

An inherent danger in the current proposals to reorganize the Department of Defense is the evolvement of a Ministry of Supply kind of set-up—the concentration of all research, development and procurement authority in a single office. A danger in this, starkly demonstrated by the British Ministry of Supply, is a reduction in the number of different ideas that are fed into the hopper. Other dangers are a widening bureaucratic gap between developer and buyer on the one hand and ultimate user on the other; increased red tape that comes with a large, multi-faceted organization.

Awards

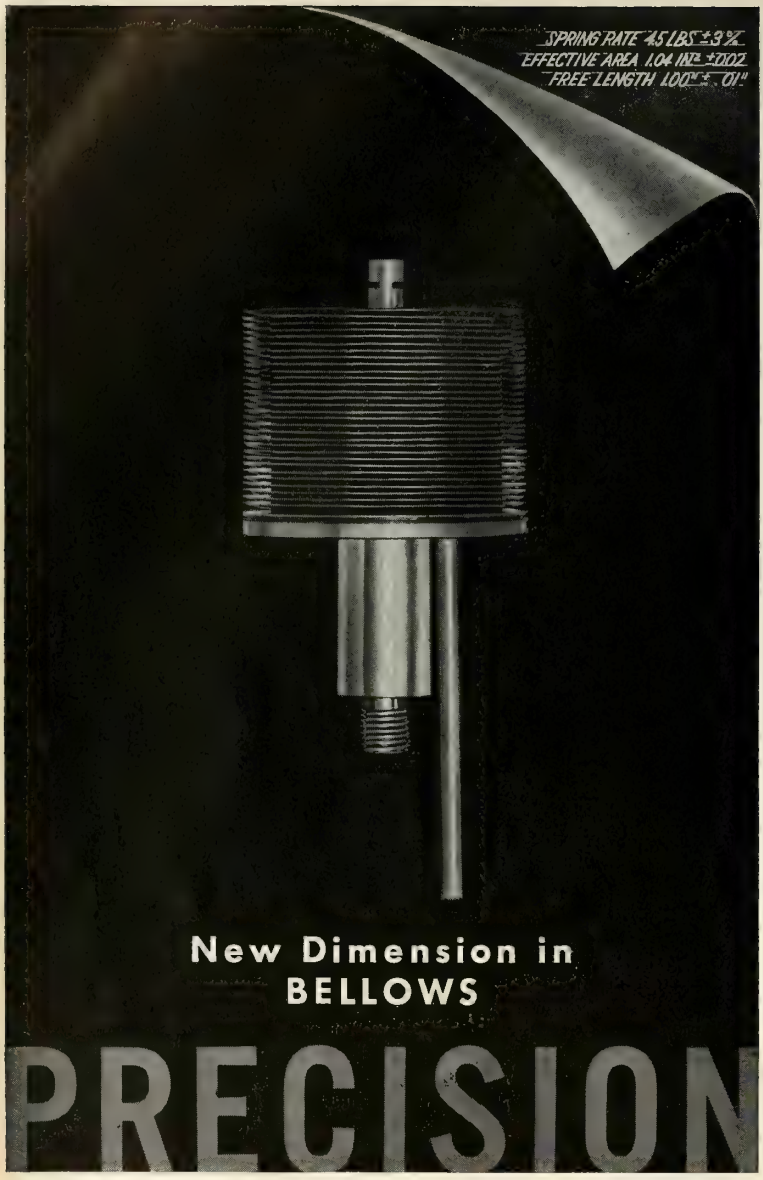
By Commander, HQ, AMC, Wright-Patterson AFB: Servo Corp. of America received $326,090 for infrared receiving set. Boeing Airplane Co. received $474,229 for a handbook study of B-52 special weapon delivery capability. Thiokol Chemical Corp., Utah Div., received $597,145 for product improvement of the M-16 rocket engine in support of *Matador* missile. The Martin Co. received $10,192,000 for TM-76A missile data and spares. Lockheed Aircraft Corp. received $200,000 for MB-1 special store flight test on F104A aircraft, and $551,582 for special weapons flight test evaluation program on model F-104A air-planes. Sperry Gyroscope Co., Div. of Sperry Rand Corp., received $188,657 for control, directional type S-3B for support of SM.

By New York Ordnance District: Allen B. DuMont Lab., Inc. received $59,673 for evaluation of high resolution missile tracking system. Belock Instrument Corp. received $82,296 for design, engineering and fabrication of a guidance and control system. Columbia University received $60,000 for analysis of radar noise in the *Nike* and related systems. Knapp Mills, Inc. received $51,868 for an irradiator. Coordinating Research Council, Inc. received $65,000 for research and development work on fuels, lubricants and related materials.

By Boston Ordnance District: Arthur D. Little, Inc. received $101,230 for complete area toxic rocket weapons system.

By HQ, Air Force Office of Scientific Research, ARDC: Columbia University received $47,000 for continuation of research on sampled data feedback control systems. University of Michigan received $36,490 for continuation of research on "standnig detonation wave", Vitro Laboratories, Div. of Vitro Corp. of America, received $65,000 for investigation of the high intensity arc for ion propulsion. University of Michigan received $36,000 for research in "mechanism of boundary layer stability and transition." General Dynamics Corp., General Atomic Div., received $91,249 for investigations of the interaction of hydrogen and oxygen atoms with surfaces. North American Aviation, Inc., Rocketdyne Div., received $90,438 for analytical studies on ion propulsion. Polytechnic Institute of Brooklyn received $27,000 for continuation of research on "information processes". Cornell University received $48,645 for research on "probability theory and analysis". Massachusetts Institute of Technology received $29,935 for a study of the mechanics for optimization of celestial trajectories. Oklahoma State University of Agriculture and Applied Sciences received $34,000 for investigations of semiconducting properties of type IIb diamonds. New York University received $25,500 for investigation of thermal stresses in structures by photoelastic techniques. Northwestern University received $53,735 for an investigation of phase transformations in solids. California Institute of Technology received $37,340 for research on "stellar compositions and the related nuclear processes". New York University received $35,031 for research on ignition and combustion of organo-metallic compounds. Carnegie Institute of Technology received $41,327 for research on "conformal and variational methods". Princeton University received $42,300 for investigations of fundamental concepts in physics. Aeronutronic Systems, Inc. received $58,705 for research on the influence of sound waves on chemical reaction rates. Litton Industries of California received $91,344 for research on high vacuum friction, and $92,923 for research on electromagnetic plasma accelerator. Bell Aircraft Corp. received $42,353 for research on "effects of damping on panel flutter", and $91,852 for research on "aero-physics of recoverable re-entry vehicles".

By HQ, AFMTC, ARDC, USAF, Patrick Air Force Base: Technitrol Engineering Co. received $59,526 for increase in funds. Westvaco Chlor-Alkali Division of Food Machinery and Chemical Corp. received $37,873 for rocket propellant. John C. Abbott received



When your specifications for design and manufacture of precision bellows require unusual know-how or close scheduling, Belfab Corporation may be your best source. Precision welded bellows by Belfab have helped solve many "impossible" problems—and almost literally helped develop new dimensions in bellows precision.

Preliminary designs, catalog and data sheets furnished on request without obligation.



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AGAWAM, MASSACHUSETTS • DAYTONA BEACH, FLORIDA

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. . . contracts

$54,540 for services and materials for Mezzanine. General Dynamics Corp., Convair Division, received $20,000 for increase in funds. Perkin Elmer Corp. received $79,776 for increase in funds. Radiation, Inc. received $175,000 for increase in funds. Cubic Corp. received $184,145 for increase in funds. Reeves Instrument Corp. received $112,293 for increase in funds. Cubic Corp. received $66,981 for services and supplies to evaluate secor and cotar equipment and prepare a final engineering report.

By HQ AFFTC, ARDC, USAF: Electronics Associates, Inc. received $39,238 for computer. Grand Central Rocket Co. received $159,781 for Viper II rocket engines. Associated Missile Products Co. received $54,868 for instrumentation system for test stand. Thiokol Chemical Corp. received $52,385 for modification and delivery of 12 "recruit" rocket engines.

By HQ Air Force Cambridge Research Center, Air Research and Development Command, USAF, Laurence G. Hanscom Field: University of Alaska received $49,983 for research directed toward a study of ionosphere in high latitudes. Rantec Corp. received $35,206 for analysis of basic design techniques and fabrication of breadboard model flat-plate radar antenna. Temple University received $50,000 for research directed toward the attainment and utilization of high temperatures. Metal Hydrides Inc. received $91,585 for research on the preparation of semi-conductor silicon from silane. Northeastern University received $75,000 for research in statistical communications theory and reliability. General Communication Co. received $29,987 for beacon radar. Stanford Research Institute received $99,110 for research on radiation and reception of electro magnetic energy from aircraft and guided missiles. Bendix Aviation Corp., Research Laboratories Div., received $54,971 for instrumentation to measure the composition of the atmosphere at 300-mile altitudes. Bendix Aviation Corp., Research Laboratories Div., received $61,922 for design, development and construction of a modified Bendix Model 15-100 spectrometer adapted for rocket installation. Allied Research Associates, Inc. received $55,635 for research directed toward the testing and evaluating of forecast procedures. Ball Bros. Research Corp. received $32,917 for design and construction of a rocket-borne monochromatic camera. Cornell University received $54,000 for radio scattering in the troposphere. Sylvania Electric Products Inc. received $34,422 for infrared scattering study.

By U.S. Naval Ordnance Laboratory: Contractor Heppenstall Co. received $28,000 for mandrel Mach 10 nozzle rough-machined forging type 303 stainless step-down bore.

By District Public Works Office, Eleventh Naval District: Staiger Construction Co. received $48,000 for correction of explosion damage.

By Navy, Bureau of Ordnance: Ford Instrument Co., Div. of Sperry Rand Corp., received $14 million for the production of electronic computers for the *Tartan* and *Terrier* guided missile systems.

By HQ, Mobile Air Materiel Area, USAF, Brookley AFB: Bendix Aviation Corp., Pioneer Central Div., received $94,708 for liquid oxygen content gauge.

By Ogden Air Materiel Area, USAF: Northrop Div., Northrop Aircraft, Inc., received $503,601 for rocket mission evaluators.

By HQ, AFTC, ARDC, USAF, Edwards AFB: G. W. Galloway Co. received $179,269 for the design and development of a nitrogen and helium testing system.

By AFMDC, ARDC, USAF, Holloman Air Force Base: Coleman Engineering Co., Inc. received $90,066 for modification of liquid propellant sled. North American Aviation, Rocketdyne Div., received $447,000 for liquid propellant rocket sled system.

By Dept. of the Navy, Office of Naval Research: Douglas Aircraft Co. received $48,671 for research on high temperature polymers. Batelle Memorial Institute received $35,000 for research on the high temperature properties and alloying behavior of platinum-group metals. Northwestern University received $25,000 for research on time constrained logistical decisions. Ramo-Wooldridge Corp. received $49,456 for research involved in perfecting solid state, low temperature computing elements. Lockheed Air-

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What's new in TITANIUM welding:

Resistance and fusion welding as fabrication procedures have become increasingly important with the advent of missiles and aircraft designed for sustained operation at Mach 3 and better.

Titanium alloys are available which provide fusion-weld efficiencies of 100 percent, and spot-welded joints with excellent load carrying capacities.

Through its new Toronto, Ohio, rolling mills —designed specifically for titanium operations —Titanium Metals Corporation of America can provide light-gage flat-roll weldable products of consistently highest quality, on the fastest delivery schedules, at the lowest possible price in the industry today.

Q. What are the leading welding grades?

A. Ti-75A, a single-phase unalloyed grade which is readily formable; Ti-5Al-2.5Sn, a single-phase alloy grade which provides excellent resistance to oxidation up to 1200°F; and Ti-6Al-4V, a duplex-phase alloy grade with guaranteed minimum tensile strengths to 130,000 psi. Guaranteed minimum mechanical properties of these grades are:

GRADE	DENSITY	Guaranteed Room Temperature Properties		
	lb/cu in	0.2% YS	UTS	Elong, % in 2"
Ti-75A	0.163	70,000	80,000	20
Ti-5Al-2.5Sn	0.162	110,000	115,000	10
Ti-6Al-4V	0.161	120,000	130,000	10

Q. Are special precautions required for welding these grades?

A. Titanium is spot-welded more readily than aluminum and many of the carbon and low alloy steels, and requires no special precautions. Spot-weld machine settings used for titanium and stainless steel are very similar.

Titanium is fusion-welded with inert-gas-shielded arc welding techniques and joint designs which are also similar to those used for other metals. Two fundamental principles must be considered:

1. Coated electrodes and other fluxing compounds cannot be used.
2. Titanium weld joints must be shielded from the normal atmosphere with an inert blanket of argon or helium during welding.

Q. Does that mean chambers are mandatory for fusion welding?

A. No. Open air welding is adaptable to production operations when both root and face of the weld are protected from the air. Small parts and complex shaped weldments which are difficult to shield adequately may still be welded more easily and economically inside a chamber. This is described in detail in TMCA's publication, *Titanium Welding Techniques,* Engineering Bulletin #6.



Successful titanium welding techniques have enabled fabricators to produce missile propellant storage bottles which resist internal pressures of 8000 psi at —300°F. This all-titanium bottle, produced by Rheem Manufacturing Company, Downey, Calif., is Ti-6Al-4V, fusion-welded in an argon atmosphere. Designers say use of titanium bottles can add up to 700 miles to the range of an IRBM.

Q. Are titanium welds more susceptible to corrosion attack than the base metal?

A. Titanium welds offer the same excellent corrosion resistance as the base metal. Stabilizing heat-treatments, employed with many other materials, are *not* required.

Successful welding is a key factor in today's designs. It enables designers to draw upon titanium's unique combination of properties: light weight, corrosion resistance, and ability to withstand operating temperatures from –300°F to 1000°F — for the added performance vital to these uniquely critical times.

Titanium Metals Corporation of America has just completed the first comprehensive study of welding techniques yet published by the industry. This 32-page publication draws upon metallurgical considerations to recommend and explain techniques required for quality titanium weldments.

Titanium Welding Techniques, as well as other publications, in the most extensive data library in the industry, is available from Titanium Metals Corporation of America, 233 Broadway, New York 7, New York. This important literature is yours for the asking.

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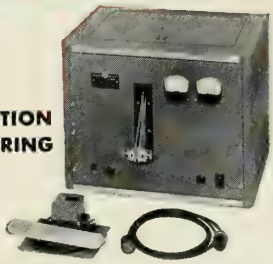
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- ☐ Bulletin 1 Properties of Ti-6Al-4V
- ☐ Bulletin 2 Heat-Treatability of Ti-6Al-4V
- ☐ Bulletin 3 Analytical Chemistry of Titanium
- ☐ Bulletin 4 Mechanical Testing of Titanium
- ☐ Bulletin 5 Properties of Ti-155A
- ☐ Bulletin 6 Titanium Welding Techniques
- ☐ Other .....

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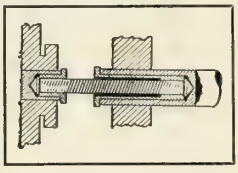
Simplifies, improves and speeds up component production. Provides local heat to otherwise inaccessible spots. Safe and simple. Max. power input 775 watts, 100 watts standby; 115 volts, 60 cycles. 15¾" x 21½" x 15". 150 lbs. Bulletin on request. Marion Electrical Instrument Co., Manchester, N. H., U. S. A.

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"WHERE ELECTRONICS MEETS THE EYE"

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FLEXIBLE SHAFT COUPLING FOR MISSILES AND ROCKETS



Coupling is used for the transmission of power or control of movement between parts located close together in a piece of equipment. It is not a separate type of flexible shaft but rather an added application of flexible shafting.

The coupling can be composed of either power drive or remote control flexible shafting although the latter is generally used due to the added advantage of its ability to rotate both clockwise and counter clockwise. Generally used between two units which are but a few inches apart, coupling may transmit power between any two parts regardless of their relative positions.

For example, the diagram above shows an advantage in using small lengths of flexible shafting in a coupling application. Although the drive end and the driven end are not exactly in line, the coupling compensates for the difference in alignment between the two.

Many manufacturers use flexible shaft coupling even where parts may be connected by solid shafts because of the savings realized in the initial and the maintenance costs as well as in time and labor.

For complete information on how flexible shaft couplings may help improve your product design, write F. W. Stewart Corporation, 4311-13 Ravenswood Avenue, Chicago 13, Illinois.

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. . . contracts

craft Corp. received $37,189 for research on electron spin echo storage.

By Dept. of the Navy, Bureau of Aeronautics: Alloyd Research Corp. received $48,792 for refining studies of refractory metals. Raytheon Mfg. Co. received $1,500,000 for materials and services to construct a flight test facility. Phillips Petroleum Co. received $94,344 for investigation of physical and chemical properties of jet fuels. Unted Aircraft Corp., Pratt and Whitney Aircraft Div., received $374,500 for reports covering design, specifications, weight and performance of nuclear propulsion systems. Crosby Laboratories, Inc. received $70,166 for study and investigation of devices for counteracting the doppler frequency shift.

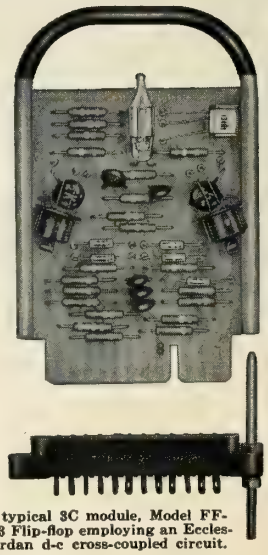
By District Public Works Officer, Sixth Naval District Bldg.: Nat G. Harrison Overseas Corp. received $111,240 for instrumentation facilities at West End, Grand Bahama Island, British West Indies for the AFMTC.

By U.S. Army Ordnance District, Los Angeles: California Institute of Technology received $7,422,654 for engineering research relating to guided missiles, free rockets, materials and wind tunnel operation. SERVO Mechanisms, Inc. received $50,123 for LOX tanking system. Douglas Aircraft Co., Inc. received two contracts totaling $87,047 for repair parts for *Nike* system. Firestone Tire & Rubber Co. received $150,197 for field service engineering in connection with *Corporal* missile and related ground handling equipment. Gilfillan Bros. Inc., received six contracts totaling $425,932 for replenishment repair parts for the *Corporal* missile system, and $168,611 for repair parts for guided missile, artillery M2 and related ground handling equipment. G. M. Giannini & Co., Inc. received $86,350 for parts and assemblies for transmitter and accelerometer. Douglas Aircraft Co., Inc. received $15,000,000 for *Nike-Hercules* launching area items. Nortronics, a Div. of Northrop Aircraft, Inc., received $350,000 for maintenance shop set for *Nike-Hercules*. North American Aviation, Inc., Autonetics Division, received $34,561 for able system. Wallace O. Leonard, Inc. received $29,720 for transducers. Electro Optical Systems, Inc. received $99,362 for investigation of ionized gases. Firestone Tire & Rubber Co. received $775,644 for engineering services related to *Corporal* missile system. Dale Products, Inc. received $305,476 for T309 testers with spares and auxiliaries. North American Aviation Inc. received $1,650,000 for rocket engines. Magnetic Research Corp. received $59,700 for temperature adapter. Firestone Tire & Rubber Co. received $28.84 for replenishment repair parts for guided missile and related ground handling equipment; $168,015 for concurrent repair parts for *Corporal* missile; and two contracts totaling $94,216 for concurrent repair parts for *Corporal* missile ground handling equipment. North American Aviation Inc. received two contracts totaling $660,000 for rocket engines. California Institute of Technology received two contracts totaling $275,020 for engineering research and development on guided missiles, free rockets, materials and wind tunnel operation. Douglas Aircraft Co. Inc. received two contracts totaling $194,125 for repair parts for *Nike* system. Convair, a division of General Dynamics Corp., received $966,720 for feasibility study of redeye system. Telemetering Corp. of America received $47,421 for technical services. Aerophysics Development received $1,498,139 for *Dart* antitank guided missile. Firestone Tire & Rubber Co. received $75,750 for guided missile surface-to-surface system. Gilfillan Bros. Inc. received five contracts totaling $665,246 for replenishment repair parts for the *Corporal* missile system. Firestone Tire & Rubber Co. received $25,306 for concurrent repair parts for *Corporal* missile ground handling equipment; $157,212 for concurrent repair parts for *Corporal*. Douglas Aircraft Co. received $40,000 for pump, vacuum and LOX tank equipment installation. North American Aviation Inc. received three contracts totaling $360,000 for rocket engines. Aerophysics Development Corp. received $462,792 for study report on drop test of *Jupiter* nose cone. California Institute of Technology received $792,275 for engineering research and development relating to guided missiles, free rockets, material and wind tunnel operation.

By U.S. Army Ordnance District, St. Louis: Denver Research Inst., University of Denver, received $29,224 for research and development effects of thermal cycling between subzero and moderately elevated temper-

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M PACs

M-PACs are fully compatible, transistorized, digital, plug-in, printed circuit modules. M-PACs provide the utmost in compactness — as many as 75 PACs may be mounted in a standard 8¾ inch rack panel space.



A typical 3C module, Model FF-103 Flip-flop employing an Eccles-Jordan d-c cross-coupled circuit.

The M-PAC family includes flip-flops, pulse amplifiers, gates, buffers, emitter-followers, variable frequency oscillators, crystal-controlled oscillators, inverter amplifiers, one-shot multivibrators, and others.

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- data handling
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- instrumentation
- computing systems

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Track testing is a new and useful tool for evaluating—prior to flight—the reliability of the essential components that go into our missile and weapons systems. Today, at Project SMART, with rocket sled vehicles, the mission is to simulate the actual conditions of supersonic flight, and to study the effect of emergency bail-outs on both men and equipment.

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But it is bigger than that!

This railroad reaches back to America's recognition of the dignity and value of human life . . . and extends to the future perfection of safety in the air.

Coleman

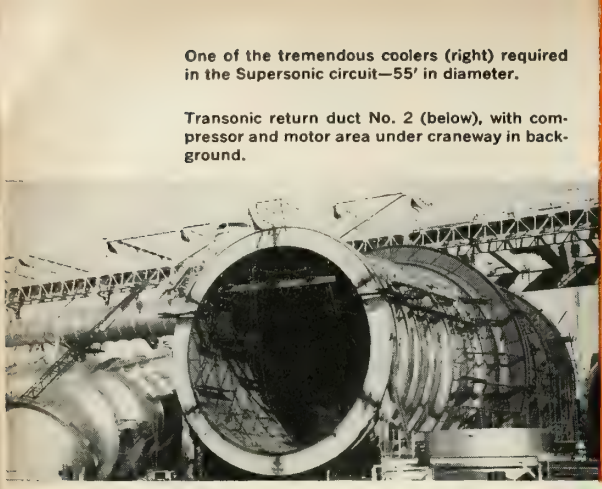
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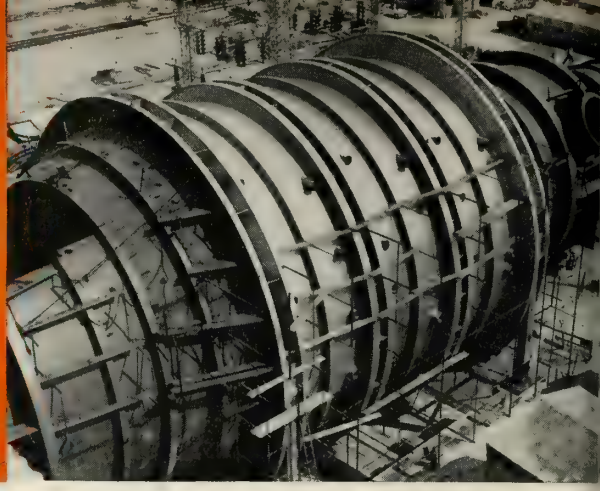
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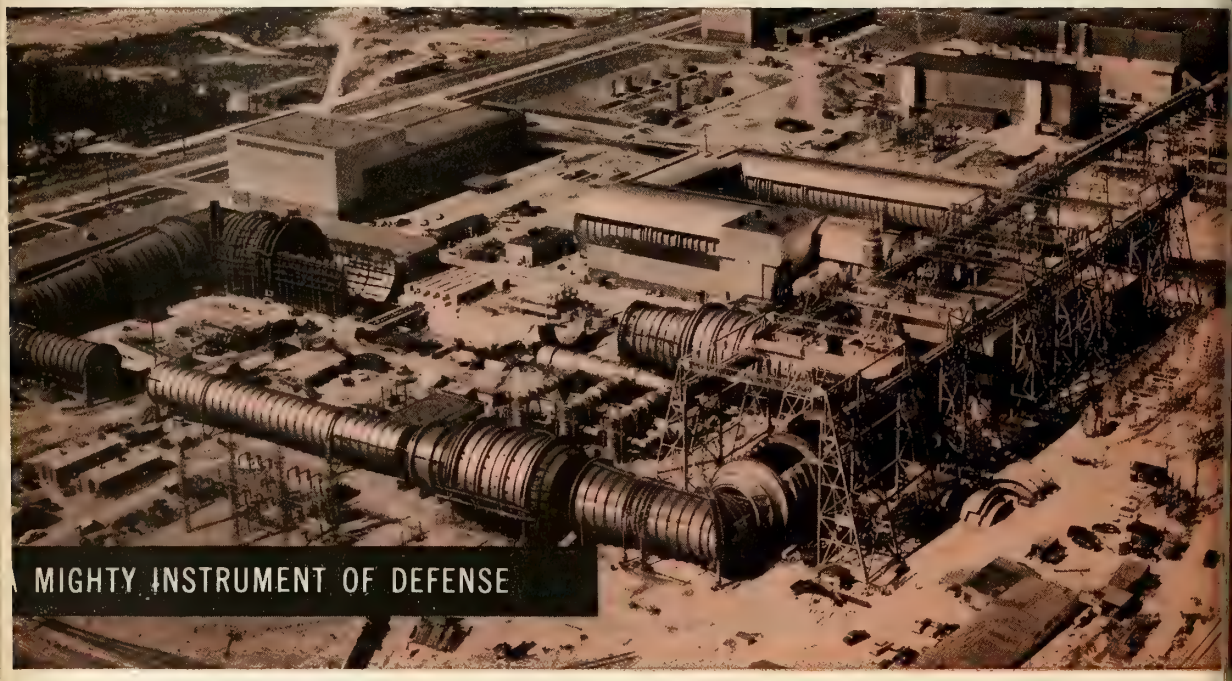
One of the tremendous coolers (right) required in the Supersonic circuit—55′ in diameter.

Transonic return duct No. 2 (below), with compressor and motor area under craneway in background.





Steel Platework by Pittsburgh-Des Moines



The Propulsion Wind Tunnel Facility at Tullahoma, Tennessee

The two largest wind tunnels of their speed in the country are shown built and under construction by PDM in the picture above. The Transonic Tunnel, now in operation, and the Mach 5 Supersonic Tunnel going up beside it are projects of the Arnold Engineering Development Center, Air Research and Development Command, USAF. The U.S. Army Corps of Engineers is the construction agency. ● The size and complexity of this work are a measure of Pittsburgh-Des Moines' ability to meet dependably your most exacting platework requirements. Write us for consultations and preliminary estimates on your forthcoming projects.

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. . . contracts

atures on the tensile properties of materials.

By Philadelphia Ordnance District: Douglas Aircraft Co., Inc. received four contracts totaling $152,437 for *Nike* spare parts and components. Western Electric Co., Inc., received 20 contracts totaling $1,964,489 for *Nike* spare parts and components. N. C. State College of Agriculture and Engineering, University of N. C., received $30,000 for investigation of brittleness cause in ceramics. Radio Corporation of America received $52,745 for government facilities for use in *Talos* defense unit. Textile Machine Works received $96,559 for thruster. Air Products, Inc. received $2,163,514 for semi-trailer, liquid oxygen.

By San Francisco Ordnance District: Ampex Corp. received $56,000 for end use guided missiles and related material.

By Cleveland Ordnance District: Goodyear Aircraft Corp. received $1,236,887 for fixed price contract with price redetermination for *Nike-Hercules*. Ohio State University Research Foundation received $29,450 for research into bodies in a fusible heated airstream.

By U.S. Army Ordnance District, St. Louis: Midwest Research Institute received $27,980 for research and development of magnus airforces in aeroballistics.

By Springfield Ordnance District: Data Control Systems, Inc. received $92,533 for telemetering station.

By Redstone Arsenal, U.S. Army: Brown Engineering Co., Inc., received $45,000 for engineering, design and drafting services necessary for the development of rocket motors and launchers. Southern Associated Engineers, Inc., received $377,785 for engineering, incidental services and materials related to the preparation of ordnance drawings for the guided missile program. Hydromatics Inc., received $31,823 for pressure-operated valve assembly.

By Frankford Arsenal: Norden-Ketay Corp., Precision Components Division, received $52,500 for synchro receiver.

By U.S. Army Engineer District, Corps of Engineers, Detroit: Douglas-Cloud Co. received $265,418 for construction of supporting tactical facilities at special AAA sites.

By U.S. Army Engineer District, Corps of Engineers, Norfolk: Equipment Engineering Corp. received $55,669 for elevator improvements.

By U.S. Army Engineer District, Corps of Engineers, Los Angeles: P. J. Walker Co. received $426,001 for nose cone training facility at Cooke AFB. Westmont Engineering Co. received $134,174 for elevator improvement and conversion at special AAA sites.

By U.S. Army Engineer District, Corps of Engineers, Chicago: Mayfair Construction Co. received $294,400 for construction of additional facilities at special AAA sites.

By U.S. Engineer District, Corps of Engineers, N.Y.: C. W. Lauman and Co., Inc. received $107,760 for special AAA facilities.

By Corps of Engineers, U.S. Army, Omaha District: Olson Construction Co. received $416,673 for construction of rocket assembly. Korshoj Construction Co. received $94,065 for construction of rocket storage facilities.

By U.S. Army Engineer District, Corps of Engineers, Charleston: Boyle Construction Co. received $67,991 for construction of high altitude training building.

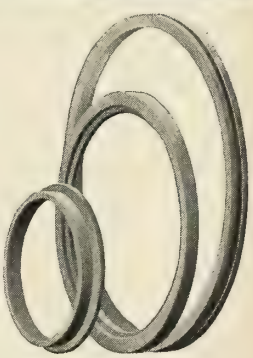
By U.S. Army Engineer Area, Corps of Engineers: James Farina Corp. received $191,770 for construction of elctro magnetic laboratory and electronic lab airborne facility.

By Corps of Engineers, U.S. Army, Office of the District Engineer, San Francisco: Clarence Ward Construction Co., Inc. received $490,159 for rocket assembly building.

By Army Map Services, Corps of Engineers, U.S. Army: Product and Industrial Engineering Corp. received $33,000 for U.S.S.R. topographic map engraving of Czechoslovakia.

By U.S. Army Engineer District, Corps of Engineers, Mobile: Whaley Co. received $202,973 for construction of launcher emplacement area, operations support building





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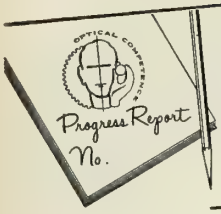
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. . . contracts

and addition to Building 4711 at Redstone Arsenal. Greenhut Construction Co. received $231,890 for construction of Model II shelters for *Bomarc*-Est facilities at Eglin AFB. Perusini Construction Co. received $155,960 for construction of nose cone assembly and check-out facility at Redstone Arsenal.

By District Engineer, U.S. Army Engineer District: George A. Rutherford, Inc. received $138,274 for G/M lab mechanical testing Holloman AFB. Allen M. Campbell received $1,325,855 for guided missile assembly building. C. H. Leavell and Co. received $88,041 for meteorological test facility, White Sands Proving Ground. The Costanze Construction Co. received $279,147 for special AAA conversion for *Nike-Hercules*.

By U.S. Army Engineer Div., New England, Corps of Engineers: J. H. Manning Corp. received $196,000 for construction of rocket storage building.

By General Stores Supply Office: Thiokol Chemical Corp. received $35,049 for polymer powder.

By U.S. Army Signal Supply Agency: Western Electric Co., Inc. received $149,120 for solid state maser studies. Radio Corp. of America received $2 million for reports on micro-miniature module. University of Michigan received $78,000 for services, facilities and materials for conducting experimental investigation of microwave radiometry techniques in detection of airborne targets. Western Electric Co. Inc. received $347,700 for services and materials for study and investigation related to transistors and transistor-like devices. Ramo-Wooldridge Corp. and Pacific Semiconductors Inc. received $95,858 for study on variable capacitor diodes. Haller, Raymond and Brown, Inc. received $79,462 for study of long-range intercept and data processing equipment and techniques.

By 308 Customhouse, Wilmington, N.C., U.S. Army Engineer District: Thompson and Street Co. received $958,800 for construction and rehabilitation.

By U.S. Army Ordnance Missile Command, Redstone Arsenal: E. I. Du Pont De Nemours & Co., Electrochemical Dept., received $59,274 for hydrogen peroxide. Linde Co., Div. of Union Carbide Corp., received $99,450 for liquid nitrogen and liquid oxygen. Thiokol Chemical Corp. received $304-882 for continuation of R&D work on solid propellant-type engines for large rockets.

By U.S. Army Ordnance Missile Command, Redstone Arsenal: Grove Valve and Regulators Co. received $29,875 for valves and regulators.

By U.S. Army Electronic Proving Ground Procurement Office, U.S. Army Signal Supply Agency: Motorola Inc. received $60,207 for study of the techniques employed in automatic plot of enemy signal origin, electronic countermeasures and the automatic data processing system.

By Procurement Office, Aberdeen Proving Ground: Fidelity Construction Corp. was awarded $25,159 for construction of rocket static firing barricade, and gun and rocket firing barricade. High Voltage Engineering Corp. received $26,400 for beam analyzing and stabilizing system-accessory.

By U.S. Army Electronic Proving Ground Procurement Office, U.S. Army Signal Supply Agency: Pacific Div., Bendix Aviation Corp., received $29,523 for telemetering supplies.

By HQ, AFOSR: University of Ill. received $27,750 for experimental research upon the electronic properties of non-metallic crystals. Columbia University received $29,550 for research on "paramagnetic resonance absorption spectroscopy." Western Reserve University received $75,000 for research on "factors controlling non-linear phenomena in ferromagnetic and ferroelectric ceramics." American Institute of Physics received $35,790 for collection and evaluation of literature in the field of fluid physics. University of Michigan received $100,000 for research on "investigation of crystal defects by electron-spin resonance." Horizons, Inc. received $26,556 for research on "rare earth carbon systems." University of Maryland received $62,750 for research on "solid state theory; $112,058 for mathematical research in fluid dynamics and applied mathematics; and $47,258 for "theoretical research program in statistical mechanics and chemical physics."★

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missile business

by Seabrook Hull

Missiles have come of age. For proof note that a mutual fund called Missiles-Jets and Automation Fund, Inc., has now been formed. Its fundamental investment policy is based on the anticipated long-term growth trend of this field. A registration statement was filed with the Securities and Exchange Commission on May 8, covering a proposed offering of 500,000 shares of capital stock at $10 per share. A nationwide underwriting group headed by Ira Haupt and Co. is expected to offer the shares early in June.

Mutual funds—a sort of pay-as-you-go deal, whereby you buy shares in a comprehensive portfolio on a regular basis—have, in recent years, come into wide popularity. Unlike insurance, as a means of saving, mutual funds appreciate not only according to the brilliance of a management company's investment acumen, but according to the inflation of the economy as well. This particular fund will be interesting to watch, since its portfolio will largely cover that industry which now produces missiles, rockets and space flight equipment.

Andrew G. Haley, partner in the D.C. law firm of Haley, Wollenber & Kenehan; president of the International Astronautical Federation; General Counsel of the American Rocket Society; is president and director of the Missiles-Jets & Automation Management Company, which will direct the fund's affairs. Another of the fund's directors is Dr. Theodore von Karman who, along with Haley, was fundamental in the founding of Aerojet-General Corporation.

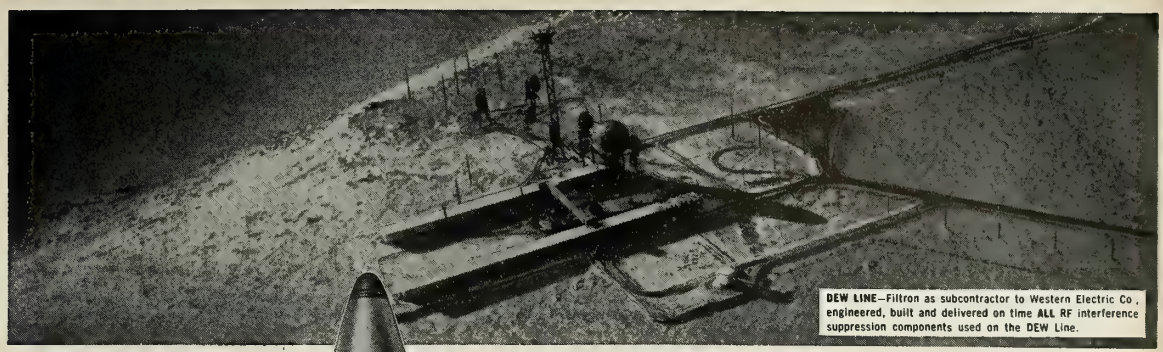
Now for the gripes: First of all, this column notes an increasing tendency on the part of government contractors to grant prime missile systems contractors facilities contracts. This is all fine, and it's human nature to try to keep as much of the business in the house as possible and to get Uncle Sam to foot as much of the bill as possible.

However, considering the vital needs and growing plight of the American taxpayer, the question being asked more and more is this: How about checking the availability of facilities already in existence before forking over millions of dollars for duplication.

Note for example, the recent award to a West Coast rocket-maker for metal-working and heat-treating capacity; to a New England prime systems contractor for small-gyro-making capacity; to a Southern company for a "from-the-turf-up" solid-rocket motor casing plant?

This business is all right for stuff that doesn't already exist or is a vital part of a hyper-critical R & D operation. But as a duplication of existant production capacity, it not only nicks the taxpayer unnecessarily into funds that would otherwise be placed for essential R & D and/or production missiles.

Congress is in session now. If you've got any gripes of your own or want to pick up these cudgels, now's the time to do it.



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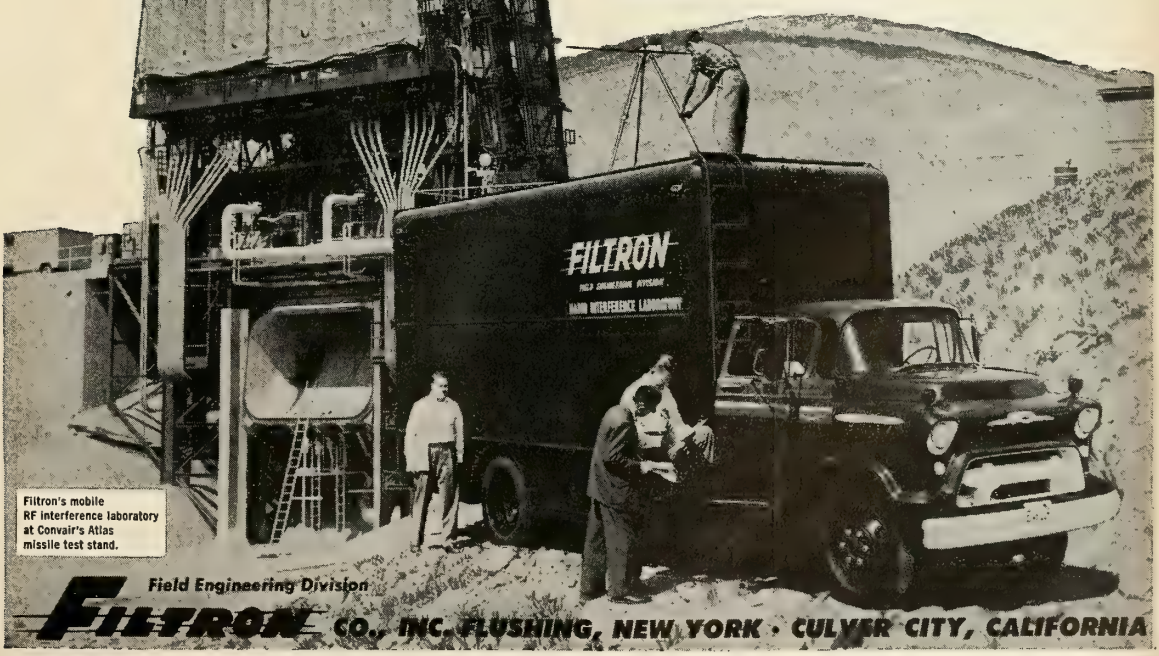
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Filtron's mobile RF interference laboratory at Convair's Atlas missile test stand.

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Circle No. 104 on Subscriber Service Card.



west coast industry

by Fred S. Hunter

Rocketdyne recently regrouped its engineering functions. One of the more important changes had to do with establishment of one group for large engine systems and another for small engine systems.

This company has been associated in the public eye mostly with its larger rocket engines. But it is pretty busy in the small engine field, too—Vernier engines that range from 500 to 3,000 pounds thrust.

One of Rocketdyne's past efforts was development of a liquid 2.75 that the Army tested on helicopters at Camp Rucker. But small engines cover a wide range. Rocket powerplants as big as 20,000, 30,000 or 40,000 pounds thrust come under the jurisdiction of the small engine group. Anything, as a matter of fact, up to V-2 size.

Keep your eye on Northrop Aircraft's new Nortronics division. It's coming along fast. It has more than 1,800 workers in electronics manufacturing, a backlog of more than $60 million, and a general manager with vision, Dr. William F. Ballhaus.

Bigger furnaces?—Robert Archer, president of California Doran Heat Treating Co., which recently installed a three-zone tower furnace capable of handling work to 48 in. diameter and 16 ft. long, said missiles soon will require a furnace capable of handling 10 ft. diameters and lengths up to 24 or 30 ft. California Doran is already working on designs for a king-size furnace.

Archer admits concern, however, over a phase of government procurement, which worries a lot of subcontractors. This is government installation of competitive equipment. It would cost about $700,000 for a 10 ft. diameter furnace, including building to house it, control and operating equipment. That is a lot of investment, Archer points out, "if the government is going to compete with us."

In complete disregard of the surrounding peril, a family of owls built a nest in the top of the *Atlas* ICBM static test tower at Convair's Sycamore Canyon test site. "I guess," a test engineer wryly remarked, "the owls don't think much of the project."

Hughes Aircraft's cushioned containers used for shipping *Falcon* GAR rockets have been improved to absorb more shock. The new DFSC-3 containers are airtight and spot tested through 18 rough-handling methods.

National Aviation Corp. now holds 10% of Marquardt Aircraft Co. This is the third biggest block of Marquardt stock. The other two blocks are: Laurence S. Rockefeller, 20%; Olin Mathieson, 25%.

Ryan Aeronautical is working on a "stand-off" missile for the Navy. Project is called Ryan M109.

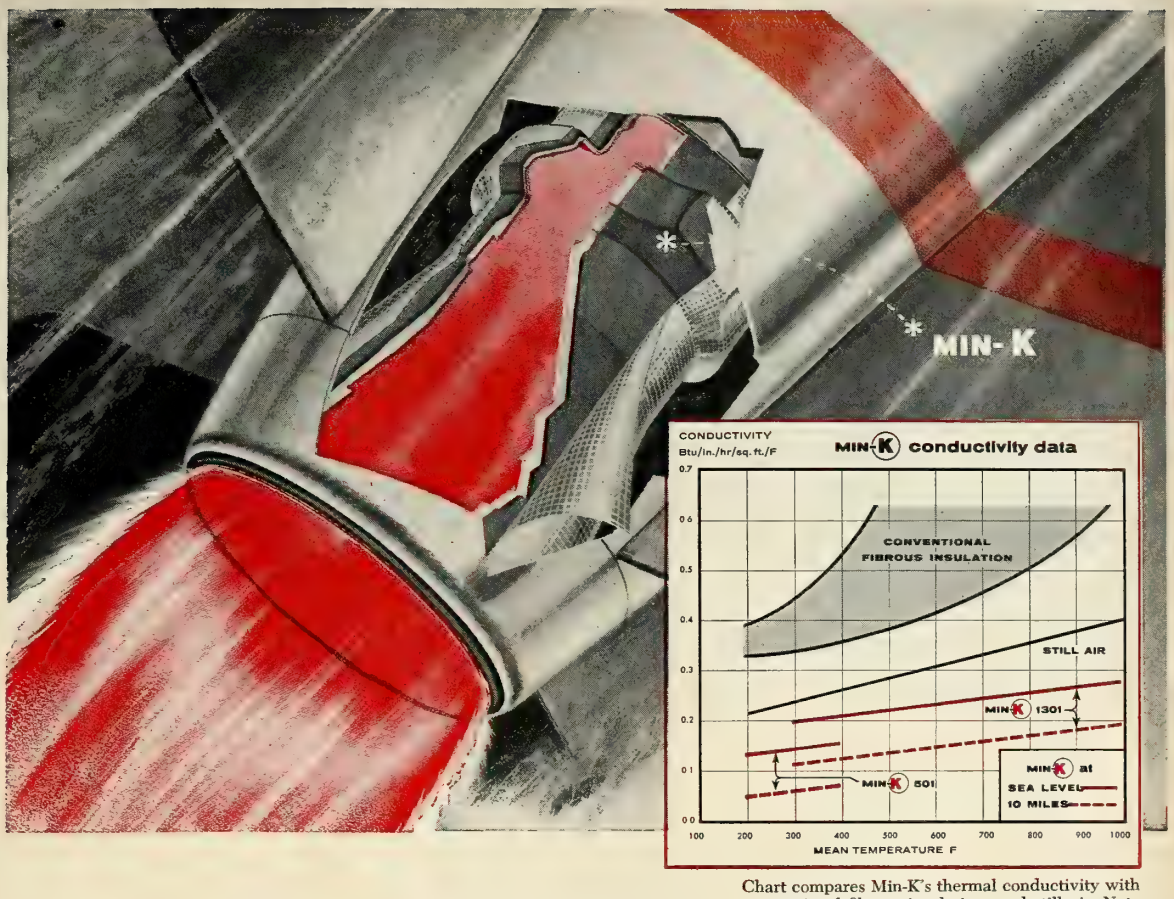


Chart compares Min-K's thermal conductivity with conventional fibrous insulations and still air. Note that Min-K's conductivity decreases with altitude.

Johns-Manville announces . . .

A scientific break-through in missile insulation!

New MIN-K has lower conductivity than still air—performs better the higher it flies

- **Saves missile space to boost fuel capacity and range**
- **Protects instrumentation more effectively to increase accuracy**
- **Offers lower thermal conductivity than any known insulating material**
- **Now performing successfully in operational U. S. missiles**

Min-K is in every meaning of the term—a scientific break-through!

For in Min-K, Johns-Manville research scientists have developed an insulating material entirely new in concept, an insulation so effective that its thermal conductivity is actually below what was long called the ultimate—the molecular conductivity of still air.

Increases accuracy and range

With this new low in thermal conductivity (less than half that of the best fibrous insulations), Min-K contributes to greater accuracy by providing more effective protection of temperature-sensitive instrumentation . . . increases range by conserving space for greater fuel storage.

Insulates better the higher it flies

Unique with Min-K is improved performance at altitude, for its thermal conductivity drops appreciably as atmospheric pressure decreases. At an altitude of 10 miles, for example, Min-K's thermal conductivity is decreased by as much as 40%, and further decreases at higher altitudes!

Manufactured by J-M as integral parts—Min-K insulations are precision molded to any shape you specify . . . encased in high-temperature metal foils or laminated to reinforced plastics. Min-K insulations include a wide variety of strengths, densities and temperature resistances.

For detailed information about Min-K, write Johns-Manville, Box 14, New York 16, N. Y. (Ask, too, for aviation insulation brochure IN-185A.) In Canada, Port Credit, Ontario.

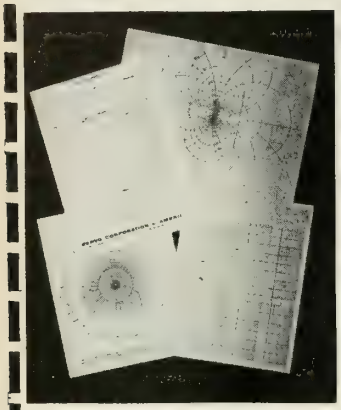
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The Complex Plane Conversion Chart, Worksheet #104, should be particularly helpful. On it are plotted the loci of constant closed-loop gain (in units of voltage ratio) on the horizontally axial circles, and the constant-loop phase (in degrees) on the vertically axial circles. These loci are plotted over Cartesian coordinates, the ordinate of which represents the unreal, and the abscissa the real, component of the gain vector.

Suggestions for an uniform procedure in working up the different curves are included.

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space age



by Norman L. Baker

• **Radiation belt**—A crash program for launching satellites at larger angles of inclination from Cape Canaveral is under consideration as a result of the high radiation belt encountered by *Explorer* I and II. Tentatively identified as either protons or X-rays emanating from the sun, the intensity rate recorded might make travel beyond 1,000 miles impossible. Yet, space medicine scientists are not deeply concerned. Latest postulations consider either localized concentrations, or a belt a thousand miles in depth—making extended flights in the radiation regions unnecessary.

• **Liquid propellant engineers** are now conceding that their position as competitors in the next generation of long range missiles can only be assured by switching to storable fuels. Liquid oxygen, long the workhorse oxidizer, will gradually give way to oxidizers such as nitrogen tetroxide combined with unsymmetrical dimethyl-hydrazine or hydrazine itself. Acid, an excellent oxidizer, is on its way out. Even under the best storage conditions, acids eventually contaminate and erode everything that comes in contact with them. This has been demonstrated in the exorbitant overhaul and repair contracts now outstanding in the *Nike Ajax* missile system.

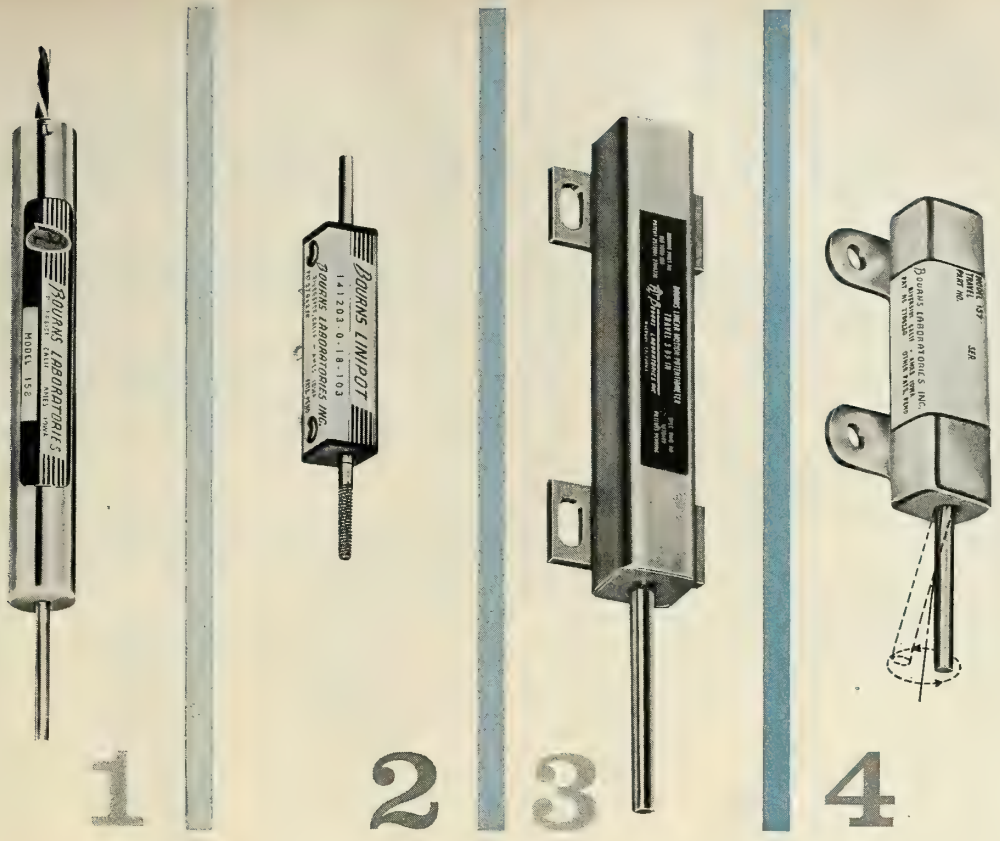
• **Contract negotiations** for the *Minuteman* ICBM are undergoing a period of muddled confusion. Competition is at an all time high. Astrodyne, the Air Force dark horse, has begun the switch to castable propellant manufacturing facilities, but needs help from the AF in developing facilities that could handle the large grains needed by the *Minuteman*. Successful development of five to eight foot grains is still months away, contrary to the Navy's claims of *Polaris* FBM success.

• *Sputnik* **IV and V**—Experts trying to anticipate the Russians next satellite achievements are predicting that one of the next two vehicles will be equipped for a reentry attempt possibly with an animal passenger. The big question—will the USSR let the U.S. make the first attempt at impacting the moon's surface? The Air Force is still denying it will attempt the first lunar probe on July 4.

• **Aero Medical scientists** in Dayton, Ohio, recently demonstrated that a man immersed in water can withstand 13 g's of acceleration for a period of four minutes. Completely mobile throughout the test, the duration of the run was limited only by the man's ability to breathe. This experimental device is reported as another Russian first. The rocket pioneer, Tsiolkovsky, proposed a similar machine many years ago. It was later proved successful in an experiment by two Soviet scientists by subjecting a frog immersed in a liquid to an acceleration of 1000 g's.

• **Top defense department** officials responsible for closing the expanding gap in Russian and U.S. satellite efforts are not impressed by the launching of *Sputnik* III. At the same time, they calmly announce that it may be two years before the U.S. can afford to divert military rockets for launching scientific satellites weighing more than a ton. The *New Horizon* (formerly *Pied Piper*) reconnaissance satellite is regarded as more important. The October shoot, planned for launch from Point Mugu into a polar orbit, will be a half-ton dummy vehicle.

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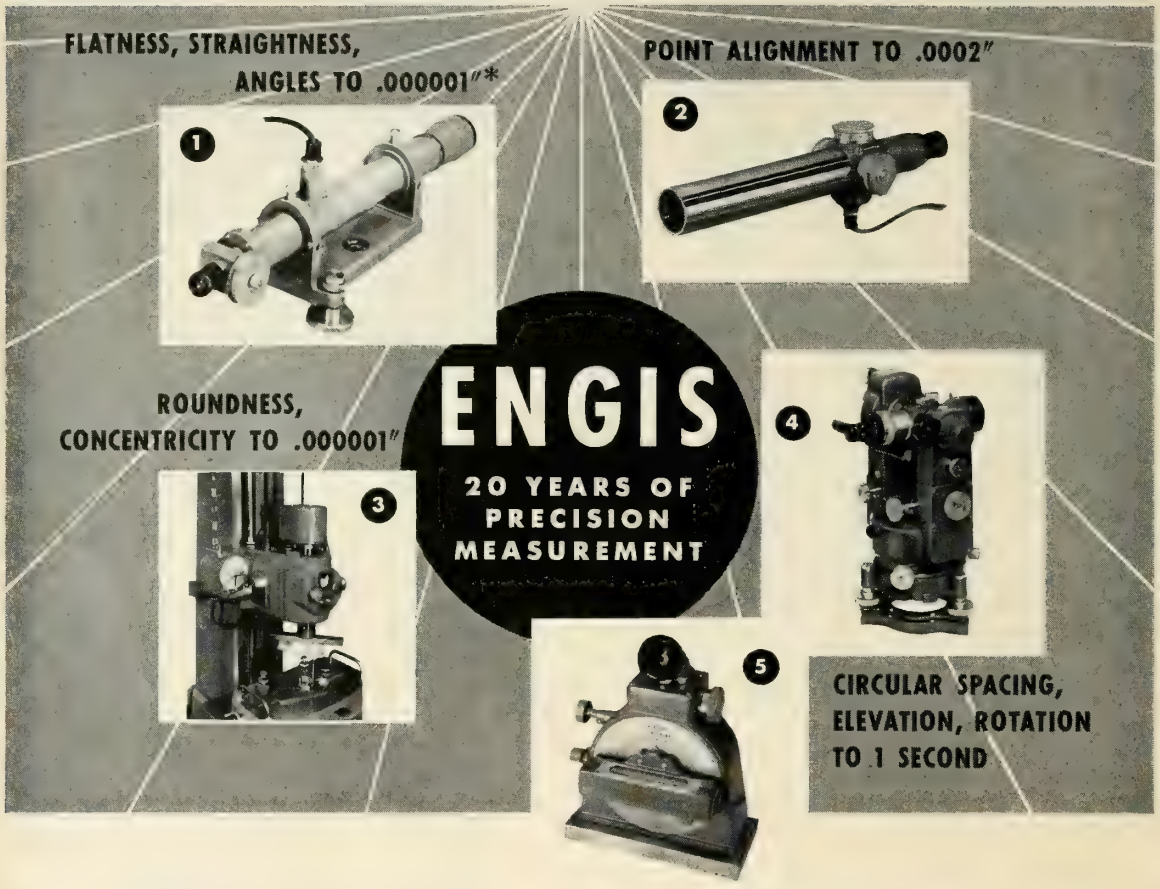
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washington trends



by William O. Miller

All the noise being made about how many *Thor* squadrons or how many *Jupiter* squadrons will be activated or sent to overseas bases is just so much sound and fury. Reliable reports are that no decision has been made, nor can be made, right now. Reason: Douglas tooled up too fast and for the moment, it can't handle immediate mass production of the *Thor* with the various modifications being plowed into the bird. Most hopeful guesses are that there will be attempts at delivery to Britain—maybe—by the end of the year.

Quietly heard among the Pentagon whispers is plans for a TCBM—Transcontinental Ballistic Missile (see page 39). Reports are that the Air Force is after the job to develop the TCBM, which is said to be in the 11,000 mile range class. Simple arithmetic shows it could hit anywhere on this shrinking planet.

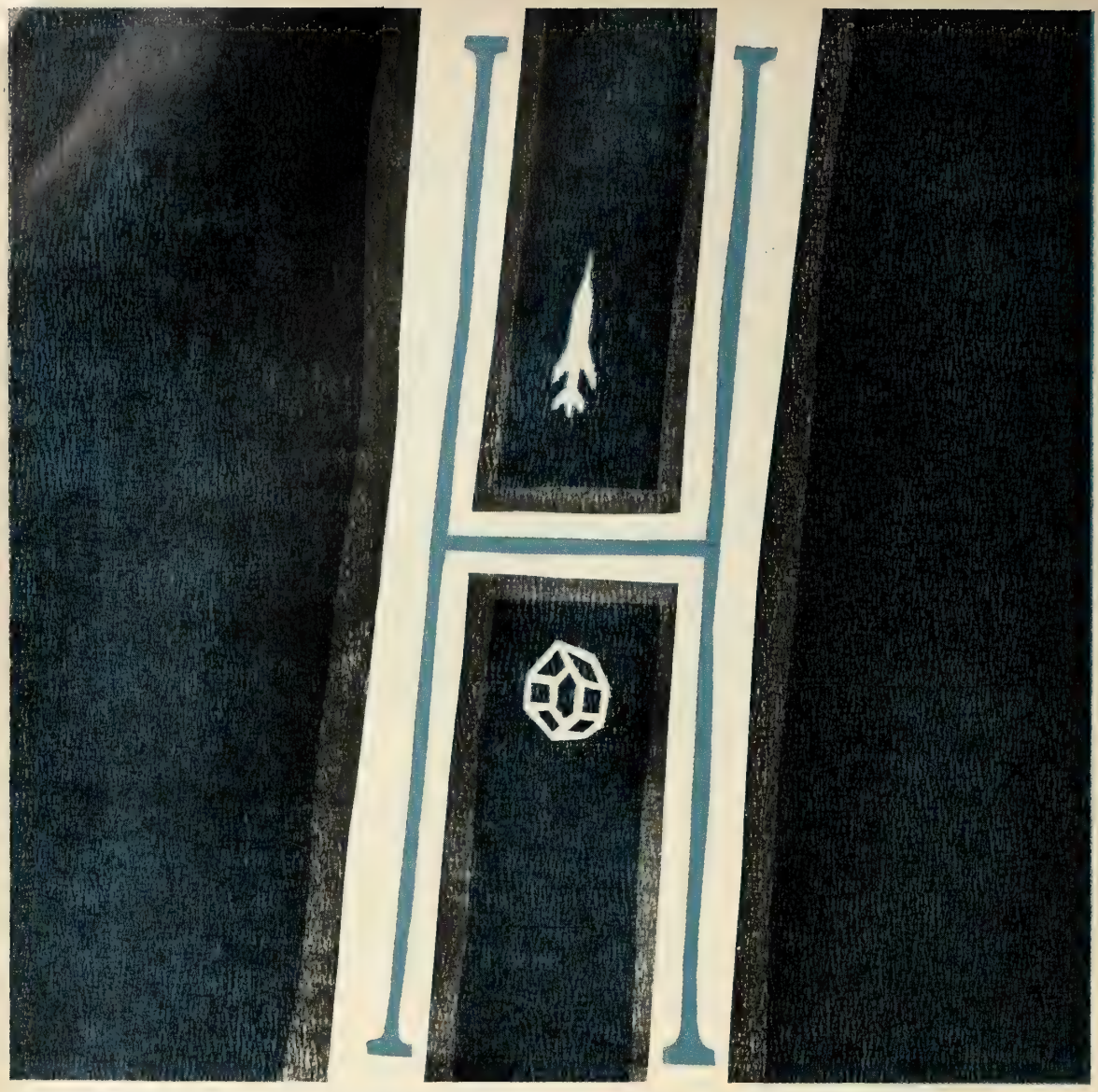
Despite statements to the contrary made by DOD information chief Murray Snyder, the Chiefs of Information of the Services have not been consulted about the proposal to take them and their departments into the "protective custody" of DOD. Perhaps Mr. Snyder was referring to the formation of an ad hoc committee, with members from each service, to study the proposal and make recommendations. Just one catch—the committee has held no meetings and there is no plan in the works, except perhaps in the office of Mr. Snyder's executive officer, John Carland.

The Rebel viewpoint was given recently during the Senate Special Committee on Space and Astronautics. An astute member of the Fourth Estate asked the Chairman of the committee, Senator Lyndon Johnson, what DOD meant. Said the Texas senator: "Democrats of Dixie."

Speculation and rumor have been the two biggest results of the current reorganization tempest. One rumor making the rounds is that Secretary of the Navy Thomas S. Gates will make a summation for the opposition and then resign. The truth: yes and no. The Navy chief may resign in the not-too-distant future, but not as a result of the reorganization squabble. And there won't be any sounding off before, if he does. Gates is a fighter, and if he backs out of the fight for what the Navy believes, it would do little more than open his influential post to a pro-reorganization appointee. Such an appointee would come from outside present Navy executive ranks. The first reason is obvious, and the second is that there really isn't a heavyweight available to take on the job. If Gates resigns, the real reason will be that he has been in the inner circle that sits on the outer circle of the Pentagon for five years already. He's been heard to say any man loses his usefulness after just so many years in the rarified Potomac atmosphere.

A second report is that DOD is dickering with the star of the Army missile team, Wernher von Braun, for a job in ARPA. Forget it. Second only to his loyalty to the U.S., is the missile expert's loyalty and concern for holding together the team he has built at Huntsville.

Testifying before the Senate Space Committee, Roy W. Johnson, director of the Advanced Research Projects Agency, said that if the Atomic Energy Commission was formed on the basis of "Atoms for Peace" . . . it wouldn't have gone very far. Thus, Mr. Johnson reasoned, ARPA should be formed under the DOD on a military war-time basis, rather than on a "space for peace" basis. (DOD, rather than a civilian agency, would be the decision-making agency). Also, Mr. Johnson added that "military-oriented people are more alert in emergencies." (?). He gave as an example the aircraft industry of today, which he said was spurred by the military needs of aircraft, rather than civilian.



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VOL. 3 NO. 7

JUNE, 1958

missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

U.S. Pushing Big Family of New Missiles

Air Force Proposes 11,000 mile TCBM

by Erik Bergaust

We are far behind the Russians (and probably will be for another five years), but you can't say we aren't trying to catch up! U.S. Air Force is believed to be pushing a new concept in long-range missiles—the TCBM or Trans-Continental Ballistic Missile, with a range of 11,000 miles, almost halfway around the globe. Despite the "no comment" from Air Force officials, m/r's traditionally reliable sources have indicated the new missile will essentially be an *Atlas* or *Titan* with skip-glide characteristics, i.e. with small aerodynamic surfaces or wings. Purpose: Air Force will be capable of launching a missile toward any target on earth from homeland bases.

Meanwhile, the Navy—as predicted by this writer in the April 1958 issue of m/r—is pushing harder than any one of the services toward a truly sophisticated missile program. The Navy has more than a dozen new missiles in the works including one which may turn out to be "the ultimate" in air-to-air defense. Undoubtedly the Navy's goal is to become the number one service as far as missiles are concerned.

• **ARCON is a Navy research missile** in the design and development stage. The missile has been statically tested and is approaching final production. Developed by Atlantic Research Corporation, the *Arcon* is a solid-propellant missile.

• **IRIS is another research vehicle,** also built by Atlantic Research. This missile is reported to be somewhat nearer production than *Arcon*. It is a solid-propellant rocket.

• **XKDT-1 is a new rocket-powered Navy** target drone, sometimes referred to as *Teal*. Under a Temco Aircraft contract the XKDT-1 is designed as a high-speed target for Navy air-to-air missiles such as *Sparrow, Sidewinder* and others. Temco's remarkable contribution to the missile business often has been overlooked. One Washington official says, "Temco's work on the XKDT-1 is so remarkable it indicates they (Temco) is in the missile business for good."

• **The Navy is reported** to be particularly proud of its new air-to-air missile, the EAGLE. This weapon—for which no development contract as yet has been awarded—is termed the "most sophisticated air-to-air system ever thought of" by experts close to the Navy. No details have been revealed.

• **BETTY (Mk90)** is another sophisticated weapon developed by the Navy. An offshoot of *Lulu,* the Mk90 is a nuclear depth charge which can be launched from ships as well as aircraft. No details are available.

• **In the same category** as the *Betty* is the Navy's HOT POINT, a nuclear warhead missile designed for anti-airfield bombing. The weapon also can be employed against marine targets, such as surface vessels and subs.

• **The sailors also** have something in mind for their mothballed battleships in case things should get hot and they would have to re-commission them. KATIE reportedly is a missile projectile capable of being fired from battleship 16-inch guns. It would carry a nuclear warhead.

Most interesting of the new Navy missiles seems to be the new family of air-to-surface weapons. Nuclear warheads are reported to be considered for all of them. Only one contractor has been named. Sources have revealed that all of the weapons are beyond the research and development stage.

• **BOAR, which is definitely** equipped with an atomic warhead, is unguided. The missile is rocket boosted. It is in production. Royal Industries is believed to have a production contract.

• **RAVEN is another air-to-surface** weapon for the Navy. No production contract has been awarded. A hot-gas generator propulsion system is reported to be employed.

• **HOPI might represent the most advanced** of the Navy air-to-surface vehicles. Undertaken by NOTS, the *Hopi* carries a hydrogen warhead and is beyond the development stage.

Navy missile men also are pushing their forthcoming family of underwater missiles. While it took the sailors many, many years to accept and understand the concept of this obvious approach to modern warfare, much has been done to catch up. Only a few weeks ago the development contract for the EX-8, a sophisticated rocket-powered torpedo missile, was given to Aerojet. Bendix Pacific also is reported to be in on it. Furthermore, Navy's old supplier of torpedoes—Westinghouse Ordnance, Baltimore—is working on a contract to develop ASTOR, and Anti Sub Torpedo Ordnance Rocket. Status: development.

There is a report that the Oceanographic Laboratory at Woods Hole, Mass. is working on something "just out of this world" for the Navy (in terms of underwater warfare) but no details were available at press time.

• **Air Force, being hampered** by missile firing mishaps and somewhat concerned about the fact that its ballistic missile program already costs the U.S. taxpayer *three million dollars a day,* seems to be overlooking the fast-moving Navy. As is known, the Navy's efficient *Sidewinder* has been adopted by the Air Force. The Air Force also may find it necessary to adopt other Army or Navy missiles because of the all-out effort on the big missiles. However, the Air Force is pushing the MCM (Missile-Carrying-Mouse) which is reported to be an experimental, large surface-to-air missile carrying several smaller target-seeking (infra-red) anti-aircraft missiles.

Air Force also is trying to materialize its LAZY DOG missile—a small two-inch air-to-surface device to be used against troop concentrations. Developed at Eglin, LAZY DOG is reported to be "tops in anti-personnel warfare."

• **The Army doesn't have much** to brag about either. There is, nevertheless, a report that the soldiers are working hard on a new anti-missile missile called the VIGILANTE. Some sources indicate this is the Army's answer to the Air Force *Wizard* challenge. The somewhat unique *Vigilante* is in the r & d stage.

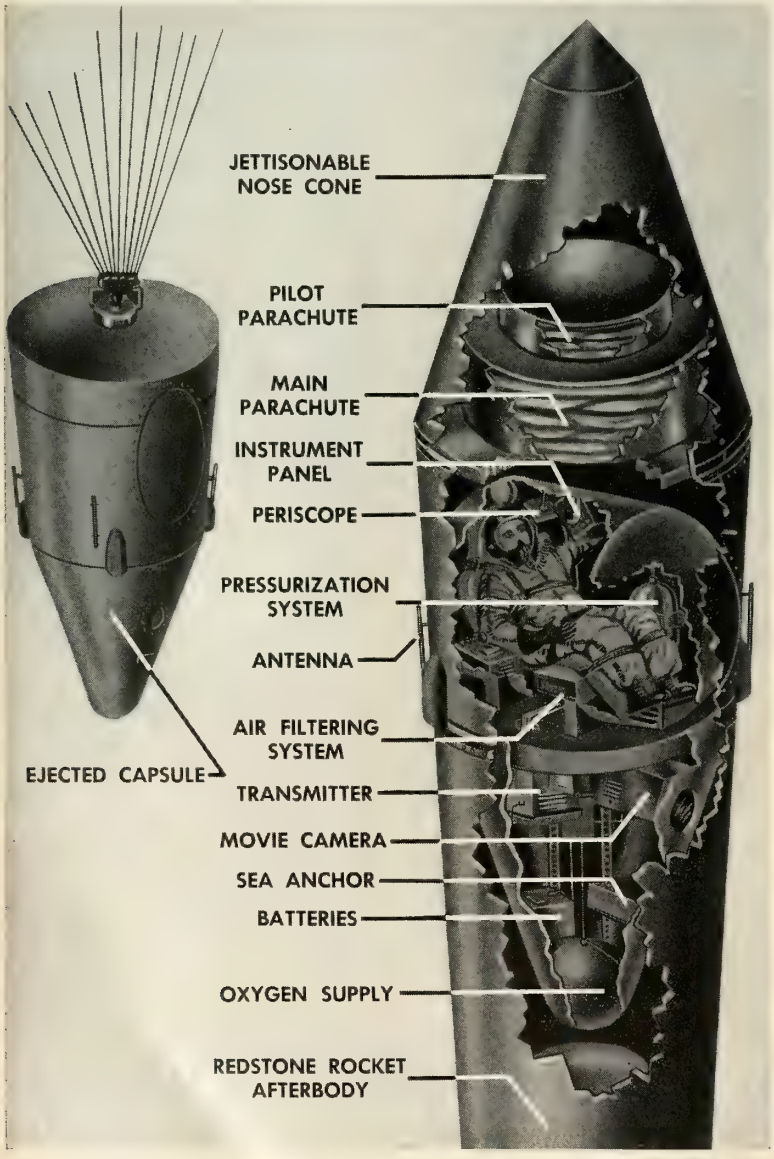
Air Force Won't Support Project *Adam*

by Norman L. Baker

Project *Adam*, an Army proposal to send a man 150 miles out into space, has been blocked by the Air Force to boost its own X-15 plans. The proposal, drawn up several months ago by members of the Army, Navy and Air Force, involves a highly formulated plan for enclosing a man within the control section of a modified *Redstone* rocket; boosting the section 150 miles up in near vertical flight; and recovering the package by parachutes.

Late last year, several high officials from the Air Force at Holloman AFB, N.M.; Randolph AFB, Texas; and from the Navy at Pensacola, Fla., were asked by ABMA personnel to participate in the design, development and program planning of the project. All officials contacted were very enthusiastic about the proposal and without hesitation volunteered their services with the announcement they were "solidly behind it."

This situation prevailed until ARDC headquarters told its personnel to "get out and stay out." Original plans included Lt. Col. D. G. Simons as designer of the capsule and its first pilot (despite his denial of it). Col. Simons has been designing capsules for years for animal flights in rockets and balloons. A Wright Aero Medical Lab official is believed to be one of the men behind the AF denouncement of the proposed project.



L. Corcoran

PROJECT *Adam* recoverable manned capsule; 70 in. wide, 120 in. deep.

• **Weightlessness**—All the people involved in Project *Adam* are determined that the chances of returning the man alive must be better than excellent. This is where a close analysis of not only project *Adam*, but also the AF manned flight in the X-15 is necessary.

Maj. Apt, while piloting the X-2, was killed when he lost control, in what is believed to have been under conditions of weightlessness. In Col. John P. Stapp's opinion, weightlessness is still the one big question to be answered before safe manned space flight is assured.

Yet, the X-15 is scheduled to fly next year without real knowledge of what effects extended periods of weightlessness will have on the pilots response control. All weightlessness tests to date have been for only seconds of time.

Complicating the safe return of the X-15 pilot still further will be the use of an untried, still to be developed, rocket engine. Its thrust will approach that of the *Jupiter*-C rocket—it will use the dangerous liquid oxygen, and yet it will not have the years of testing background and proven reliability of the *Jupiter*-C engine.

The experts say there should be two approaches to the first manned satellite. The AF has proposed that the X-15, with large rocket boosters, be utilized as the first such flight. In case of plane failure or pilot's loss of control, he would still need a proven system of automatic recovery from satellite altitude and velocity. This is the major field of experimentation for Project *Adam*.

Project *Adam* would be ready for first flights one year from the date of program approval. Any program for placing man in space with the X-15, at the current rate of development, would be two or three years away.

Project *Adam* would investigate four areas of experimentation: safety of launching rocket, weightlessness, aerodynamic heating and reentry and recovery techniques.

• *Redstone* **reliable**—Of all the rocket carriers in existence in the United States, the *Redstone* missile is the most tried and reliable. In develop-

ment since 1953, it has been fired repeatedly as a basic *Redstone* short range missile, later modified as the booster for the *Jupiter*-C configuration, and now is in the hands of Army troops. A *Jupiter*-C configuration—minus the upper staging arrangement and Hydne fuel—would be utilized for Project *Adam*.

The *Redstone* is also the most aerodynamically stable missile in U.S. arsenal. Its stability, referred to as 'arrow stability,' is similar to the stability characteristics of an airplane. In the event of engine failure shortly after launching, the *Redstone* remains in a vertical attitude throughout the remainder of its flight. This optimizes the chances of ejecting the human cargo from its nose for recovery.

The IRBM and ICBM missiles, on the other hand, do not have these control features. Within seconds after power failure, these missiles pitch over to horizontal attitude with a usual resultant explosion.

Adam would subject its pilot to at least six minutes of combined negative g's and complete weightlessness. Total flight time, from launch to return to earth would be approximately ten minutes. Pilot would go into weightless free fall about two minutes after blasting off, when the rocket reaches burnout.

Six minutes later, the drag chutes would be fully open and lowering the capsule to the surface of the ocean. Acceleration of the rocket would subject pilot to a maximum of 7 g's for slightly over ten seconds. This is well within proven tolerable limits.

Studies on the problems of aerodynamic heating, reentry and recovery principles were conducted by the Cook Research Labs of Morton Grove, Ill. at the invitation of ABMA. Cook devised the parachute-flotation equipment for the *Jupiter*-C and *Jupiter* IRBM test nose cones that have been successfully recovered in recent tests.

Early experiments involved the recovery of monkeys from high altitude (50-60 mile) rocket flights. The Project *Adam* equipment would be based upon the same principles, but much improved over the present system.

• **Equipment**—Two to three high speed drag chutes would slowly decelerate the manned capsule upon entering the atmosphere. The opening of the chutes would be automatically controlled by an acceleration-deceleration switching system, designed to hold g's forces below the pilot's limit of endurance.

The capsule within a capsule is designed to float in an upright position, similar to a buoy, after landing in the water. The equipment is arranged in the lower cone section of the capsule for attainment of a low center of gravity.

An automatic radio beacon which begins transmitting while the capsule is still in flight would guide recovery ships to the point of impact. The pilot would also be in constant radio contact throughout the flight.

Additional recovery features include flashing beacon light for night recovery, sea dye marker, and sea anchors to stabilize the bobbing capsule and prevent drifting.

The "space cabin" capsule for housing the pilot would be a cylinder about 4 ft. in diameter and 6 ft. in length. It is designed for insertion within the equipment capsule through a side access door.

It would be equipped with an oxygen supply, air filtration system, nitrogen pressuration system, recording instrument panel, emergency manual controls for attitude and parachute release control, and a periscope for external viewing.

The pilot would be strapped in a supine position in a special acceleration couch. Controls for emergency operation would be located at the 'arm rest' position to enable manipulation during acceleration.

Four flights, costing an estimated $10-12-million, have been planned. The first two flights would be equipment-test experiments, with well-instrumented monkeys as passengers. The remaining flights, fully equipped, would be manned.

In anticipation of government approval of the proposal, four out of twelve elongated *Jupiter*-C rocket carriers, constructed for satellite launchings, have been put aside for the Project *Adam* experiments.★

Propulsion, Electronics To Get Missile Money

Propulsion and electronics manufacturers may get the majority of future weapon systems business, it has been forecast by Malcolm A. MacIntyre, Under Secretary of the Air Force.

MacIntyre recently told a group of bankers in New York: "Development and production of future vehicles which are primarily electronic devices with frames designed to house the systems may be managed by electronic companies. Similarly, propulsion manufacturers may become prime contractors." He added that during the early stages of space vehicle development and production, quantity orders of 10 or less may be the business norm.

Jupiter Test Sparks IRBM/ICBM Firing Series

Although the recent successful flight of the *Jupiter* got most of its "press" from the nose-cone recovery, Army scientists are more elated about a little-known problem which the flight proved had been solved.

Problem was the propulsion system —reduction gearing in particular. Significant thing is that in prior flights, gearing that had been checked out perfectly on the ground, failed in flight. ABMA personnel recognized the problem and rectified it.

Their successful solution will now be used on the *Thor* and *Atlas* missiles, so look for a whole series of IRBM and ICBM tests in the near future.

In the test, the Army successfully fired and recovered the full *Jupiter* combat nose cone from a flight that went the design distance of 1,650 statute miles. The IRBM employed the same nose-cone recovery techniques which permitted the recovery last fall of the *Jupiter*-C test nose cone.

The important result of this test is that the nose cone survived its reentry intact, i.e., in such condition that a nuclear payload inside could have been detonated at its intended altitude. This is the first successful actual firing of a full-fledged reentry nose cone.

The *Jupiter* nose cone recovery gear was developed by Cook Research Laboratories. Chrysler Corp. is the prime contractor on *Jupiter* production. North American Aviation Rocketdyne division makes the 135,000-pound thrust liquid propellant motor.

The sequence of recovery is as follows:

While still out in space, the back cover of the nose cone is exploded away. Fifteen seconds later, a parachute is ejected explosively. This occurs at under 5,000 feet altitude, so that the bulk of the nose cone's reentry has been accomplished before it is artificially slowed. At this point the nose cone is white hot.

Prior to impact in the water, a recovery package separates itself from the nose cone by means of explosive screws. This package releases a balloon whose bouyancy keeps the nose cone near the surface, and serves both as a radio beacon and a light.

In the final stage, prior to hitting the water, the balloon trails the parachute, thus permitting the latter to take the brunt of the impact shock. After entering the water, a small depth charge fires to enable waiting recovery personnel, (estimated about 20 miles from the expected point of impact), to sound range on the location. In addition, a dyemarker and shark repellent are released into the water.★

Space Bill May End Military–Civilian Battle

House measure sets up liaison committee— Senate prepares similar space legislation

The current legislative tug-of-war on the President's proposal to create a civilian space agency could be resolved by a bill which has cleared the House Select Committee on Astronautics and Space Exploration.

The pacifier may be in a provision that would establish a special liaison committee, representing the Defense Department, which would work in the proposed National Aeronautics and Space Administration. Under the President's proposal, NASA would be a reorganization and enlargement of present the National Advisory Committee for Aeronautics—which does research on aircraft. The House bill, however, would create a much stronger independent administration that would cooperate, but not conflict with, Defense Department devolepment of military weapons.

The proposed liaison committee would settle disputes over whether a particular space project was in the province of the military or the space agency. Failing, the decision would be made by the President. The Senate is working on similar legislation.

Other features of the house bill are:

1. A precedent-setting anti-secrecy provision which would require the space administration's data to be made public, except where it can be withheld under a specific law or for national security reasons.

2. Abolishing present special House and Senate space committees, and replacement by a joint House-Senate committee like the one now handling atomic energy matters.

3. Provision of a 17-member Aeronautics and Space Advisory committee, which members of NACA would attend. Government representatives, including at least three from the Defense Department, would represent nine members.

4. Inclusion of the space administration director (Dr. Hugh Dryden, present director of NACA, has been mentioned as a likely candidate for the post) at attend National Security Council meetings. Also, the space administration should be given power to appoint 200 scientists and engineers.

• **Testimony**—During House hearings, Roy W. Johnson, director of the Advanced Research Projects Agency of the Defense Department, said he was opposed to a civilian space agency with over-all control—the agency should, in effect, handle only uncompleted projects by the military. He said he favored only an extension of the NACA.

Johnson was backed in his opinion by Defense Secretary Neil H. McElroy, and other top spokesmen for the Armed Forces. They said the President's proposal might water down military control. McElroy said the Defense Department must continue to have "funding and direction" over the "military aspects of the space program."

• **Legislation readied**—The Special Senate Committee on Astronautics and Space Exploration, which recently concluded hearings on the President's proposal, is preparing to write legislation now.

During the hearings, Senator Styles Bridges complained that the President's program has "fallen over backwards" toward civilian control, and gives too little voice to the military. A fellow committee member, Senator Clinton P. Anderson, complained that the space agency would leave the military—as well as representatives of private interests—with too much power over space activities.

Other criticism was that the Administration proposal does not provide for international cooperation in space research; fails to recognize the importance of nuclear energy for space propulsion; civilian space exploration would become wrapped in unnecessary secrecy; and the director of the space agency could act independently of his 17-member advisory board. Make-up of the board also was questioned.

Some Senate objections were removed when the Administration offered clarifying amendments. One amendment would give the government a majority of seats on the advisory board, and members of the board could not be representatives of private corporations or seeking government space contracts.

Senator Bridges' basic complaint was that in the "popularity" of the civilian control concept, too much of a barrier could be placed between the military departments and the civilian program. He asked what would happen, for example, if the agency wanted four *Atlas* missiles for its explorations and the Air Force thought the missiles were needed for defense.

Assistant Defense Secretary Donald Quarles replied that space exploration would depend very heavily on military missiles for some time to come, and "priorities" would be decided by the President.

What's in Name for Space Agency?

While direction and responsibility for the nation's space exploration, in the words of Senator Lyndon B. Johnson, chairman of the Special Senate Committee on Astronautics and Space Exploration, "seems to be scattered around in as many agencies as have an interest in the field," there also is no dearth of suggested names for a principal agency.

Here are a few:

National Astronautics Agency (proposed in Senate bill 3604)

National Aeronautics and Space Agency (President's proposal in Senate bill 3609)

National Aeronautics and Space Administration (proposed by House Astronautics and Space Committee)

Astronautical Research and Development Agency (proposed to President by American Rocket Society)

Department of Science and Technology (proposed in Senate bills 3126, 3180)

Federal Space Exploration Commission (proposed by National Society of Professional Engineers)

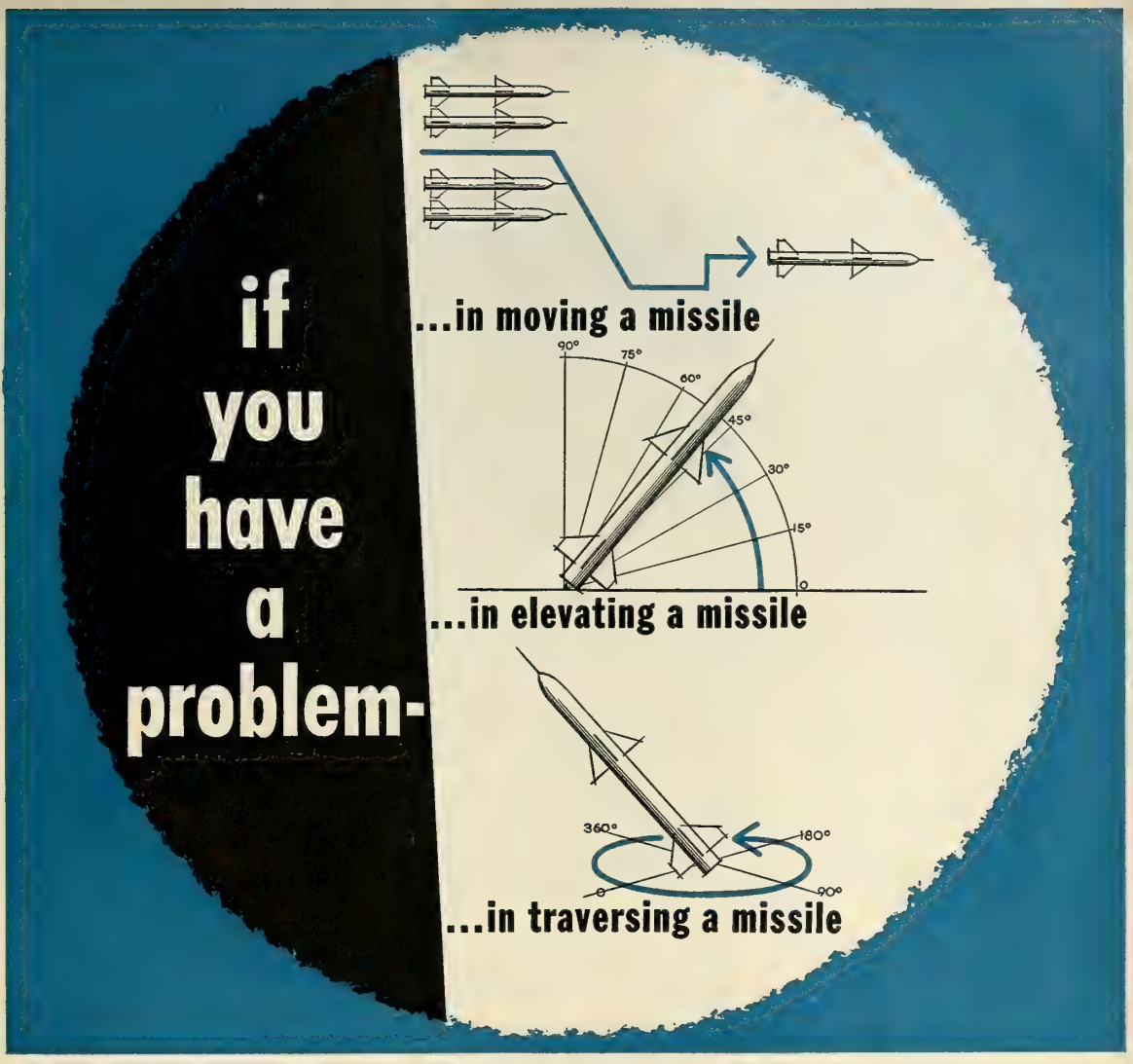
Outer Space Commission (proposed in House bills 9874, 9966).

Revised Policy Suggested On Federal Secrecy Rules

The House Committee on Government Operations has recommended that American science be freed from the straitjacket of excessive secrecy and has detailed its recommendations in a report to the House.

The committee suggested that a system of uniform security clearances, applying to scientists working for all agencies and all defense contractors, should be established to increase the efficiency and economy of the clearance procedure.

The "need-to-know" criteria should be abolished, according to the committee, so that American scientists who have passed a rigid security clearance may have ready access to the technological information necessary to help the nation regain scientific supremac



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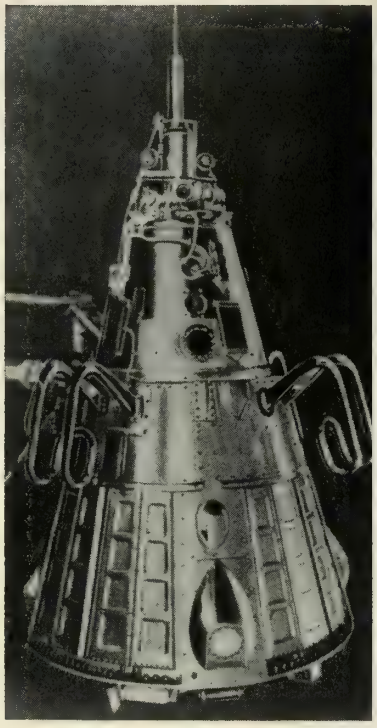
an m/r staff analysis

"On May 15, 1958, the third Soviet artificial earth satellite was orbited. The sputnik's orbital plane, like those of the first two, is at an angle of 65 degrees to the plane of the equator. At 1,167.4 miles, the third sputnik's maximum height of orbit exceeds that of the previous two. It circles the globe in 106 minutes.

"The outstanding feature of the new sputnik is its weight—2,925 pounds, almost 16 times greater than that of Sputnik I and almost 100 times heavier than America's first and third sputniks, Explorer I and Explorer III.

"Further important steps in the conquest of outer space, particularly in obtaining valuable data on the moon's surface and in the study of pre-lunar space, will require sputniks of considerable size and equipped with diverse instruments . . . Sputnik III's launching confirms the possibility of an early solution of these problems . . ."

Release by the Embassy of the Union of Soviet Socialist Republics



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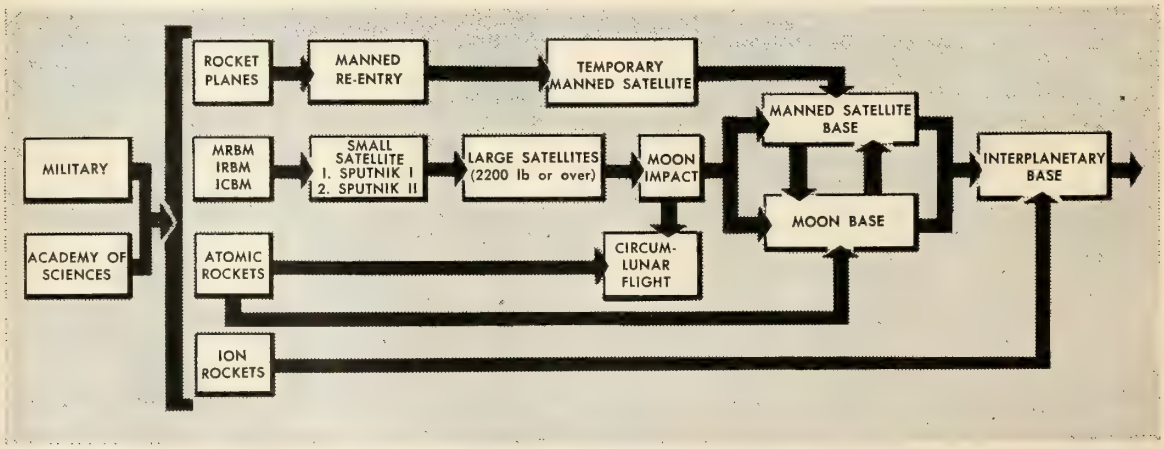
The launching of the third Soviet earth satellite should provide conclusive evidence to the United States that Russia is following a well organized and coordinated space program. Although the Soviet program as well as our own may be suffering some mishaps, it is forging ahead in tremendous strides. Ample evidence is at hand.

Sputnik III is a particularly significant achievement because of its size and weight, which demands a thrust still not available in the United States. But, just as significant, is the vast array of experiments being conducted simultaneously indicating that the Soviets may have achieved a degree of miniaturization. Dr. Joseph Kaplan, Chairman of the U.S. National Committee for the IGY, said the information obtained from the instruments in *Sputnik* III will be of tremendous value to world scientists.

The great size of *Sputnik* III "means that practically all the experiments which were done separately in smaller satellites are now being done together in one package. The data thus collected, on the intensity of solar radiation and the magnetic fields in the upper atmosphere, is likely to be more accurate than that gathered in smaller satellites where instruments must be miniaturized," Kaplan said.

This latest satellite is further warning of the advanced state of the Soviet military rocket program. Military officials disagree on the amount of thrust needed to boost the 1½-tons into orbit, but all agree that the thrust is in excess of that needed to power an ICBM. The guidance and reentry capability of the Soviet intercontinental ballistic missile is an unknown factor. But the general concensus is the belief that Soviet scientists have a workable solution to these problems.

• **Data available**—The released data on the shape and size of *Sputnik* III provides a means of estimating the size and power of the launching rockets. It is estimated that the last stage rocket orbiting ahead of the satellite nose cone is 6 to 8 ft. in diameter and approximately 70 ft. in length. This corresponds to available figures of the



OPERATIONAL CHART of the Soviet rocket, missile and space travel program illustrates the step-by-step plan of operation.

T-2 IRBM, reported to have a thrust of 254,000 pounds. The weight of the last stage is further estimated to be about 7,000 pounds.

The Soviets did not disclose the number of stages used in the launching vehicle, although it could have been either a two or three stage rocket developed especially for the satellite launching. Power to boost what is possibly 5 tons to an orbiting velocity may have required a thrust of about 800,000 pounds. This could be a single rocket engine or a cluster of three of the 254,000-lb. thrust units.

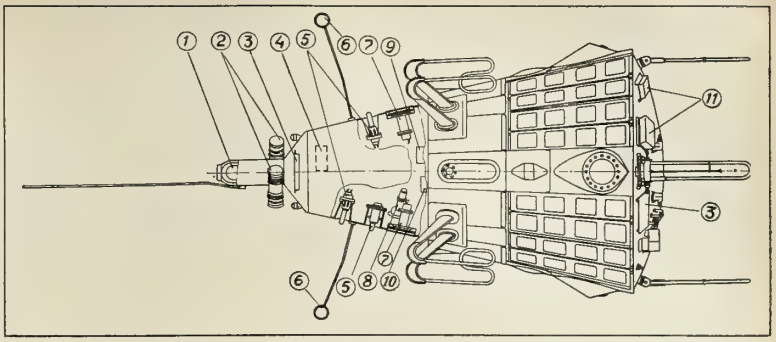
The USSR had considered sending *Sputnik* III to the moon, but, according to astronomer N. Varvarov, it was too early for the lunar probe to be worthwhile. Lack of necessary instruments for transmitting data back to the earth was given as the reason for postponing the moon shot.

Dr. Wernher von Braun said the latest Russian accomplishment merely confirms his belief that the Russians are ahead of us in the missile and space programs. "We simply have not got the rockets yet to lift a satellite of similar weight."

• **Any mishaps?**—Soviet scientists continue to deny there were any failures in this latest satellite. An Italian Communist news agency had reported earlier that an attempt had been made on May 1 and May 3. Each time the launching was postponed "due to technical difficulties." Unlike the United States' program of using the same vehicle for several flights, each of the Soviet satellites have been radically different in configuration, size, weight and instrumentation. This would necessitate additional development and modification time between individual launchings.

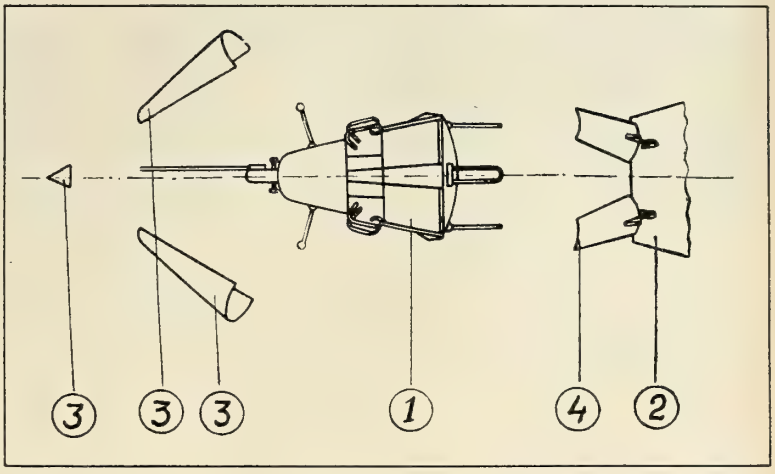
Particularly significant is the possible utility of a satellite the size and weight of *Sputnik* III as a man-carrying reentry vehicle. The Army has proposed the boosting of a man to 150 miles altitude housed in a capsule of a modified *Redstone* nose section (see page 40). This capsule would be very similar in size and weight to *Sputnik* III.

The cone of *Sputnik* III houses an instrument of every variety the United States intends to send into orbit during the remainder of the IGY. Apparently additional space is available within the cone for more instruments. Only 2,133 pounds of the total satellite weight of 2,919.53 pounds is instrumentation. Data collection and transmission should continue for the entire estimated 6 months life span as a result of its solar batteries.



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DIAGRAM of SPUTNIK III. Components include: 1) Magnetron to measure gravity, 2) photo multipliers, 3) solar batteries, 4) apparatus to register photons in cosmic rays, 5) magnetic manometers, 6) ionic traps, 7) electrostatic fluxmeter, 8) mass spectrometer tubes, 9 and 10) cosmic ray instrument, 11) micro-meteor impact recorder.



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SEPARATION of SPUTNIK III from the last stage. 1) satellite, 2) rocket case, 3) the separating protective cone, 4) shields separating from the satellite.

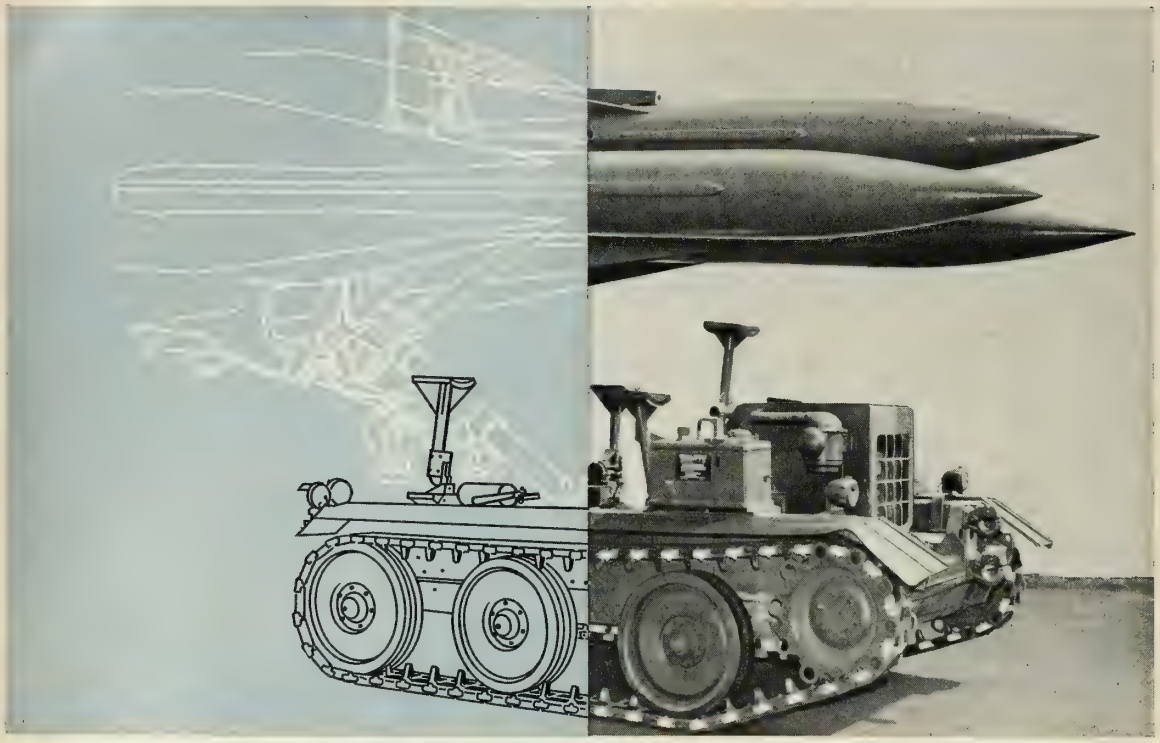


Soviet Embassy

IN A TECHNICAL radio center, the leading observation post of the SPUTNIK III satellite, the incoming radio signals are monitored on a receiving oscilloscope.

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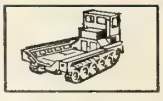
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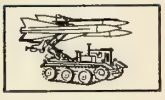
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STL Early Explorer In Space Technology

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STL today claims it is the largest professional group in the nation devoted exclusively to research, development and systems engineering in ballistic missiles, space projects, and related advanced technology.

In the electronics field, STL has a number of analytical and experimental projects in progress which are concerned with the development of advanced guidance and control systems.

The projects include investigations in ionospheric and tropospheric propagation phenomena, advanced concepts of components and circuitry design, and new techniques for packaging.

STL's is also exploring such areas as high Mach number flow phenomena, materials research, hydraulic power servo systems, dynamics of fluids in tanks, boundary layer research, high temperature gas dynamics, magnetohydrodynamics and cryogenics.

Research and development facilities at STL are in pace with the many and varied programs in aerodynamics, hypersonics, propulsion and structures. STL has an extensive computation and data processing installation, which includes two large-scale scientific digital computers, a 300-amplifier analog computer, a 30-channel analog-to-digital converter, and a specially designed data reduction center for analysis of telemetry data.

STL's primary purpose is to provide systems engineering for ICBM and IRBM. It must determine the basic design characteristics of each weapon system, define subsystem specifications and assure final compatability of the whole system.

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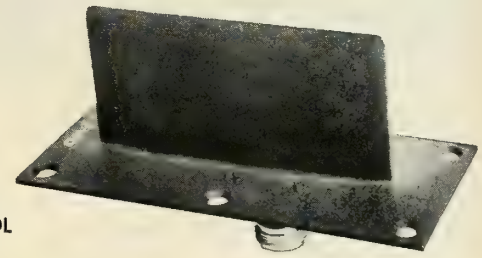
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9927	3000	25	1.5	1.30	0.75
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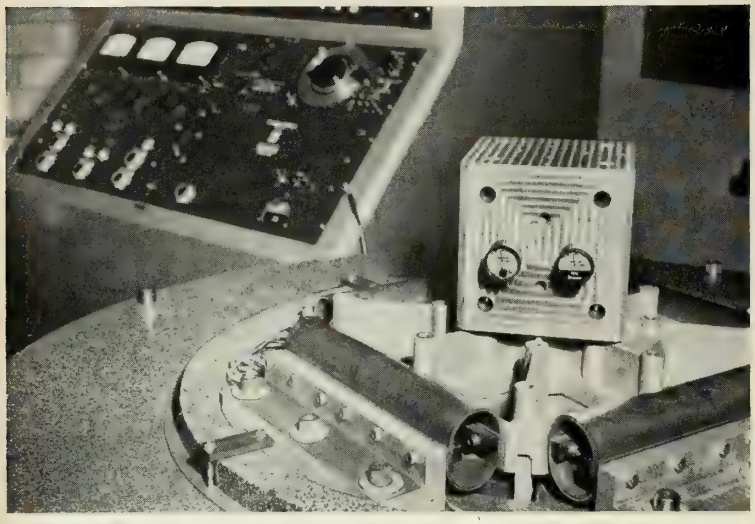
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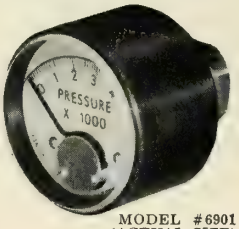
New high pressure gauge passes 25 G "torture test" with ease



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and specific analysis concerned with trajectory choice and control, guidance accuracy, and detailed control system performance.

STL carries out these efforts within the framework of an up-dated R&D plan, supported by sustained scientific and engineering investigations to insure the fundamental technical soundness of the programs.

Other areas of assistance to the Air Force include planning for logistics support, personnel requirements, and training and operational facilities required in the transition of a weapon system from the R&D phase to operational employment.

STL has indicated that the precision of control and guidance for a vehicle aimed at the moon or planets is not substantially greater than that required for the ICBM-IRBM program, and even less precision is needed to guide a vehicle into a near-circular orbit of the Earth.

The organization is headed by Dr. Louis G. Dunn, executive vice-president and general manager, who has had 22 years experience in aerodynamics, structures, jet propulsion and guided missile research.

Other key people in the organization include Dr. Milton U. Clauser, vice-president and director of the Physical Research Laboratory; Allen F. Donovan, vice-president and director of the Aeronautics Laboratory; and William M. Dunke, vice-president and associate director of the Systems Engineering Division.

HEADING Space Technology Laboratories' organization is Louis G. Dunn, executive vice-president and general manager, who has more than 22 years engineering experience.



LOUIS G. DUNN, executive vice-president of Space Technical Laboratories.

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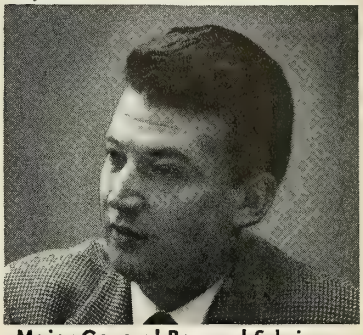
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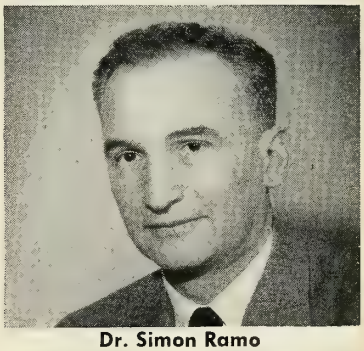
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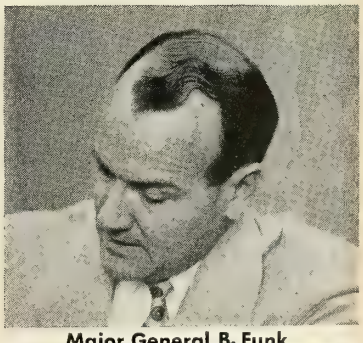
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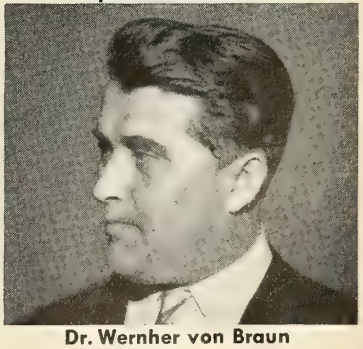

Major General Bernard Schriever

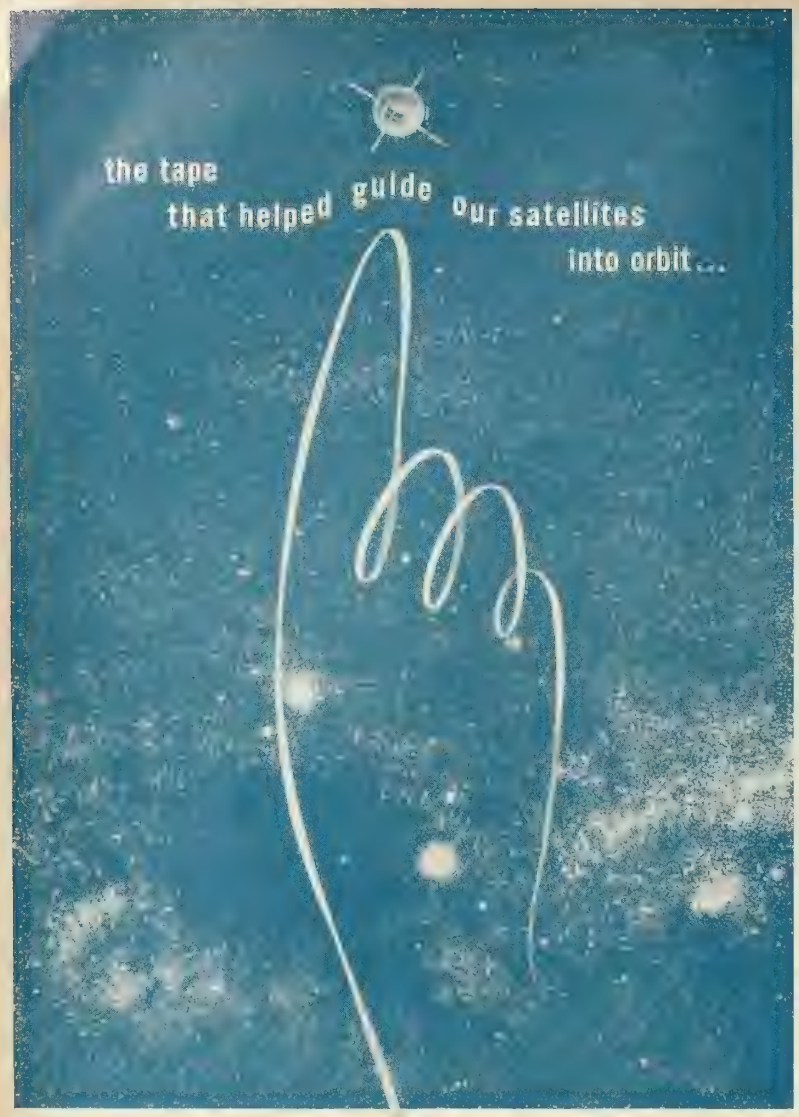

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Army Contracts Over 80% Missile Money to Industry

Of the total funds expended by Redstone Arsenal and Army Ballistic Missile Agency, over 80% are spent with industry. In retort to charges that with its "arsenal" concept, most of its funds are spent at government-owned facilities, the Army points out that of the funds spent by Redstone Arsenal during the last year for missile development, production and procurement, 92% was paid out to industry, while 8% remained in the house. ABMA states that of all the funds allocated to the *Jupiter* IRBM program, 86% went to industry.

Missiles Sales Meeting Scheduled In Hartford

The Association of Missile & Rocket Industries will hold a Connecticut Missiles Sales Conference at Hartford, June 24.

The morning session will deal with missile and propulsion sales outlook. At the afternoon session, the outlook for sales in guidance, electronics, frame and ground support will be discussed.

Representatives of government procurement agencies will participate. Firms which have indicated they will take part include Hercules Powder, Dow Corning, Borg Warner, Reaction Motors, Aerojet, Rocketdyne, Thiokol, Hamilton Standard, Perkin Elmer, Federal Telecommunications Laboratory, Sperry, Raytheon, General Electric, Philco, ARMA, Western Electric, Barth Corp., Baldwin-Lima-Hamilton, Martin, Diversey, ACF and AMF.

Erik Bergaust, executive editor, m/r, will speak at the noon luncheon.

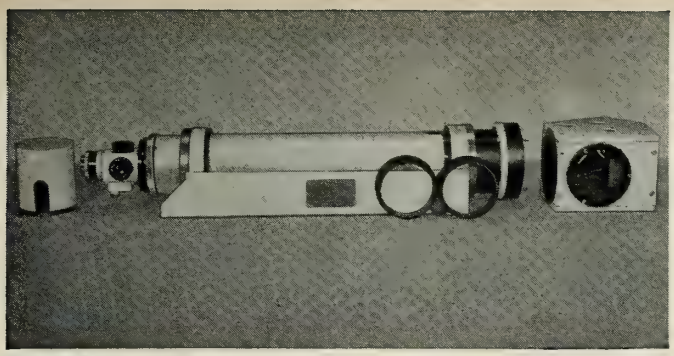
Canadian Astronautical Society Gains Members

The Canadian Astronautical Society, which was formed in Toronto last year, has now reached a membership of several hundred scientists, engineers and technicians.

The society held its second general meeting in late April, and featured an exhibition of rocket hardware built by members.

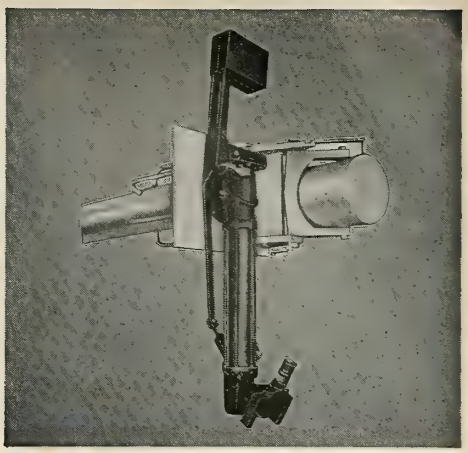
Dr. P. A. Lapp, president, reported that since the society's formation, experimental and theoretical activities are proceeding well in specialist sections such as propulsion, electronics, analysis, and astronautics.

Members of the de Havilland Aircraft of Canada, Guided Missile Division, are providing the nucleous for the society.



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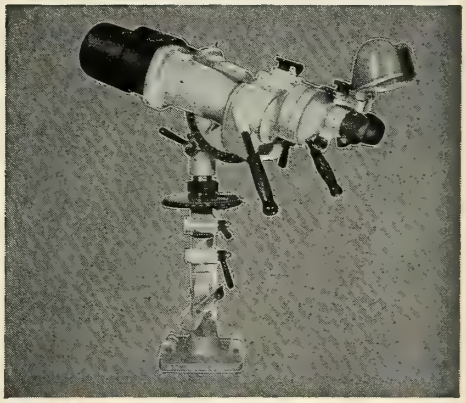
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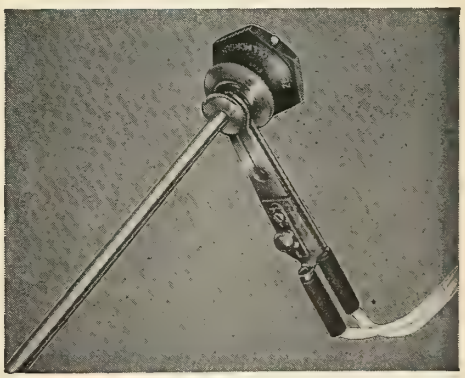
The various instruments on this page all have one purpose in common—they allow the observation and measurement of objects which it would otherwise be impossible to see in detail. In bunkers, under water, in the absence of light, in the presence of radioactivity and under many other adverse conditions, Kollmorgen remote viewing instruments have brought the eye of the observer to the heart of his problem.

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ARPA Seeks More Money For Biological Tests

Geophysicists will soon be moving over to give biological scientists a turn at bat for experiments in earth satellites, if Fiscal Year 1959 funding for the Defense Department's space division—the Advanced Research Projects Agency—is an indication.

An ARPA spokesman told m/r that new funds will include a "sizeable amount" for biological research with earth satellites, but the current need is for scientists to outline what experiments should be made in order of priority.

An important step in this direction was taken in May during a symposium on the possible uses of satellites for life-science experiments; co-sponsored by the American Institute of Biological Sciences, the National Academy of Sciences, and the National Science Foundation.

The symposium, which closely paralleled a meeting several years ago that led to geophysical research with satellites, was organized to stimulate thinking on space biology experiments which could lead to manned flight.

Scientists were assured by the government that when space biology experiments are proposed and accepted, earth satellites will be made available.

• **What's first?**—Initial experiments will fall into three broad categories: determination of cosmic radiation effects on living tissues; the effects of weightlessness on living systems; and how to provide a livable atmosphere for prolonged periods of time for the occupants.

Geophysical research with satellites is now providing invaluable information on radiation, but the effects of weightlessness are mostly an unknown quantity.

This will pose one of the great problems in satellite biological experiments, calling for an engineering design for true weightlessness, the symposium was told. Rotation and tumbling of present satellites produce an acceleration field, which does not give true weightlessness.

Another factor which will limit the solving biological experiments is the recovery of the satellite vehicle. For the biologist, telemetry cannot substitute for getting the experiment back to earth.

ARPA is serving as a clearing house for experiment proposals, until such time that a decision is made on whether the proposed National Aeronautics and Space Agency will take over direction of space biology research.

As such, ARPA is working with the Air Research and Development Command, Army Research Office, Atomic Energy Commission, National Advisory Committee for Aeronautics, National Science Foundation, Office of Naval Research, National Academy of Sciences, and the American Institute of Biological Sciences, all having interests in this field.

• **Some contracts**—Few space biology experiments are in the contract stage. Air Force has asked for bids on small animal survival capsules for launching this fall. A satellite yeast experiment to measure radiation was scrubbed with failure of a *Vanguard* launching, and will not be carried out until this fall or winter.★

m/r editorial viewpoint:

No Place for Snyderisms

Here's a news item which nobody can put an official stamp of suppression on: Ruefully-awakened newsmen covering Cape Canaveral have overwhelmingly voted Murray Snyder the public official they would most like to see take the first trip in a manned (but not recoverable) earth satellite.

We can readily assume that this distinctive title also has the blessing of the Washington press corps which must deal daily with the Pentagon, some members of Congress who are pushing for freedom of information, and Snyder's own Defense Department public information colleagues.

Snyder's record as "Czar of Pentagon Information," while never envied, has become despotic in the past nine months. With the launching of the first *Sputnik,* he hastened material into picture, print and air waves to assure this nation that anything the Reds could do, we could do better—as if this could make up for five lost years between 1945 and 1950 when the pleas of missilemen fell on deaf Defense Department ears.

Snyder managed to build up the December 6 *Vanguard* firing, an unproven scientific experiment, into a classic fiasco of politically-inspired and mishandled publicity that put the hopes of a free people at an unparalleled low.

When he realized he could not keep satellite launchings and missile firings a secret from the public at the gold-fish-bowl Canaveral testing area, Snyder masterminded an ingenious "deal" with some unthinking newsmen, who now realized they sacrificed some professional ethics by going along with him. The deal appeared harmless.

In exchange for certain "privileged, not classified" information, correspondents would not give an advance publicity build-up to a missile firing. Concessions even included grandstand seats inside the test area. It meant binoculars used at Coca Beach and the hours of waiting in unseasonably cold weather were at an end. Correspondents were to be informed in advance of any test.

This publication was not, and never shall be, a party to this or any other such agreement. We do not want "privileged" information declassified by Snyder for politically expedient reasons, but information the public has an inherent right to know. Newsmen who went along with Snyder at Canaveral learned their lesson when several tests went through without that "promised" advance notice.

Since October, Snyder, for so-called "policy reasons" which no one can define, has clamped down a lid on information that will not endanger national security. Legitimate unclassified news, purely scientific papers and even advertising copy have been the victims of his "policy reasons."

Now, by Presidential sanction and Snyder's own admission to the House Armed Services Committee, he is more than willing to take on the task of deciding what information the American public should have and understand about our defense and participation in the new era of space.

Snyder admits he will become a Supreme Censor in the proposed "consolidation" of public information functions of all branches of the Armed Forces.

Snyder's new role should raise him to new heights. But he should remember that unlimited power can corrupt the possessor and where law ends, tyranny begins. Suppressed news, when it eventually comes out, bites with keener fangs. We, for one, do not intend to stand by and let him tell a free nation what he wants them to read and think. We'll continue to spell things out.★

"...AND QUIETLY BOLD"

A Message to the Scientific Community from Dr. Hugh L. Dryden, Director, NACA

NACA has pioneered in preparations for manned and unmanned space flight for the past six years and has designed and built unique aerodynamic, structural and propulsion facilities for space research. We of NACA are moving to insure that our contributions to space technology will match our record in aeronautics. It is imperative that America lead the way in the peaceful exploration of space. Our nation has the talents and resources to do the job. But we must recall the wisdom of the Killian Committee which recently said: "Let us be cautious and modest in our predictions and pronouncements about future space activities and quietly bold in our execution."

Hugh L. Dryden

Hugh L. Dryden



Hugh L. Dryden, Director, NACA; Ph.D., Johns Hopkins University

NACA has a staff of 7,750 research scientists and supporting personnel spread among its research centers on both Coasts and in Ohio. NACA staff members in pursuit of new knowledge have available the finest research facilities in the world, including several of the largest and fastest supersonic and hypersonic wind tunnels, hot jets, a fleet of full scale research airplanes, which will include the X-15, hypersonic ballistic ranges, shock tubes, a nuclear reactor establishment, rocket facilities, a research missile launching site, tracking devices, and the most advanced mechanical and electronic computers.

NACA Fields of Research Include: Analytical Dynamics, Solid State Physics, Hypersonic Aerodynamics, Magneto Hydrodynamics, Energy Sources, Propulsion Systems, Aerodynamics, Automatic Stabilization, Vehicle Configuration and Structure, Materials, Flight Simulation, Instrumentation.

A number of staff openings are becoming available. You are invited to address an inquiry to the Personnel Director at any one or all four of the NACA research centers:

Langley Aeronautical Laboratory, Hampton, Virginia
Ames Aeronautical Laboratory, Mountain View, California
Lewis Flight Propulsion Laboratory, Cleveland, Ohio
High-Speed Flight Station, Edwards, California

(Positions are filled in accordance with the Aeronautical Research Scientist Announcement 61B)

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. . . news and trends

Filmed Space Lectures Available to Industry

A series of filmed space technology lectures, given by 36 of the nation's top astronautical experts, is available from the University of California. The films were produced jointly by UCLA and Ramo-Wooldridge Corp., and feature such space scientists as Dr. Wernher von Braun, Dr. William H. Pickering, Dr. Hubertus Strughold and Krafft A. Ehricke.

They cover the subject of space from past history to future prospects and take in the many facets of commercial uses, technical problems, human factors and communications.

With two exceptions, each of the 17 programs consist of two lectures, running a total of one-and-a-half to two-and-a-half hours. Eight companies and the Naval Ordnance Test Station, China Lake, Calif., have already contracted for the newly released films which rent for $2,300 for the complete set.

Rental arrangements can be made through O. E. Patterson, director, Department of Visual Communication, University Extension, UCLA, Los Angeles 24, Calif.

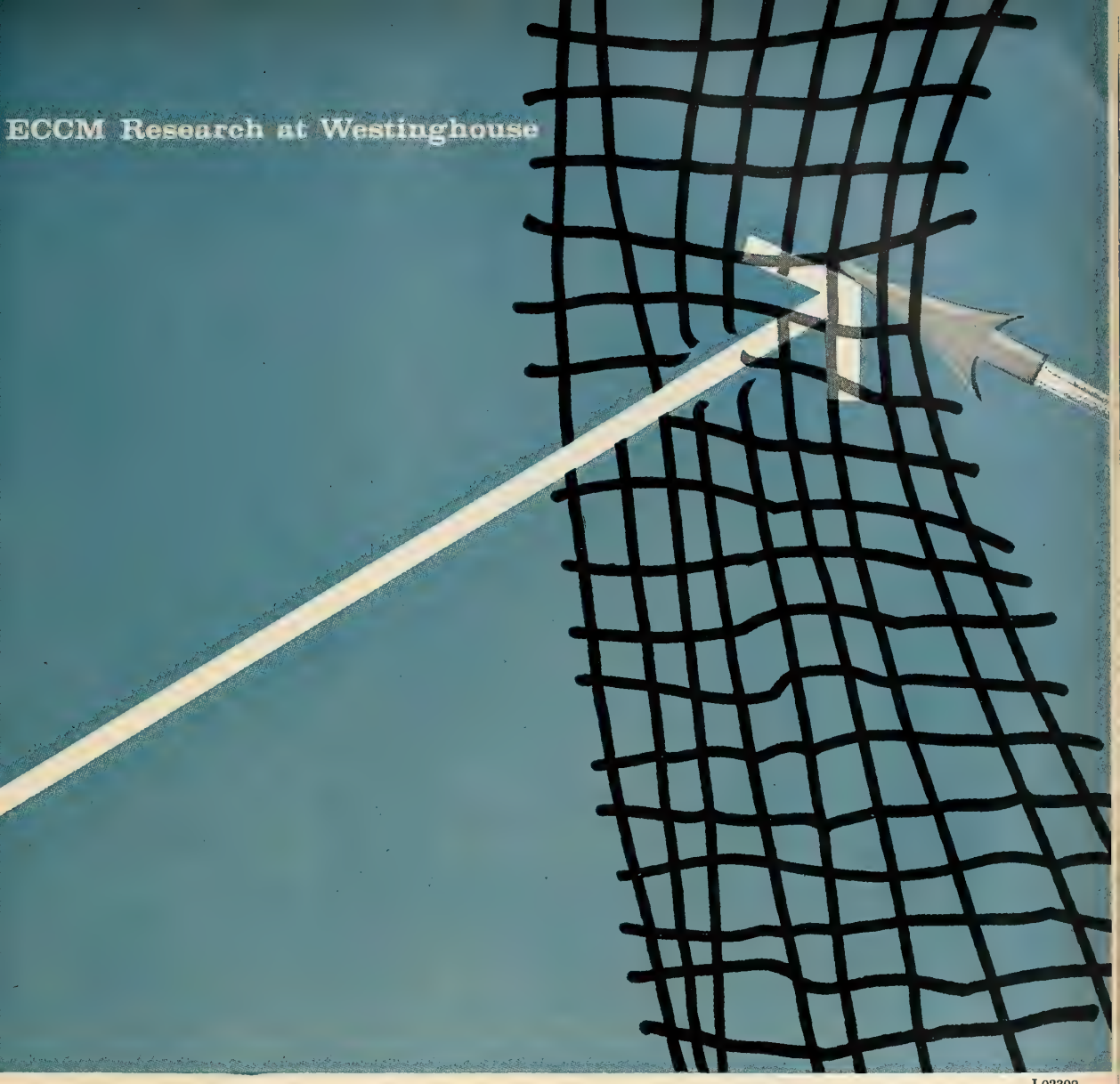
Boost-Glide Possibles Have Now Been Cut to Two

Only two companies are still in the running for the development contract for the Dynasoar "boost-glide" rocket bomber project. According to information recently received by m/r, these are The Martin Company and Bell Aircraft Co., whose Dr. Walter Dornberger first promoted this project in the U.S.

This is the manned weapon concept that would rocket-boost a hypersonic bomber to "free space" altitudes and speeds 15,000-to-20,000 miles per hour —the vehicle to glide from altitude back into the atmosphere, dropping its payload on the way. It is based on the Eugen Sanger proposal of 1935. The Russians are known to be in the advanced stages of developing and testing such a vehicle.

10th Annual IAF Congress May Meet in Moscow

Preliminary negotiations are underway between Andrew G. Haley, president of the International Astronautical Federation, and top members of the USSR Academy of Sciences to hold



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next year's IAF Annual Congress in Moscow.

"Moscow would be particularly appropriate in view of . . . the immense contribution of the USSR in all branches of astronautics," Haley said. If the Russians turn the proposal down, the Tenth Annual Congress will be held in Washington, D. C.

Other subjects under discussion in Moscow include (1) whether Prof. Leonid I. Sedov of the Russian Science Academy would accept the presidency of the IAF to succeed Haley, and (2) progress of the IAF Cooper Committee which is attempting "to define the regions of air law and space law jurisdiction."

The committee, which will submit its findings to the United Nations, is comprised of the following members: United States, Chairman John Cobb Cooper, Dr. L. R. Shepherd, Dr. Athelstan F. Spilhaus, Andrew G. Haley; Germany, Dr. Alex Meyer; USSR, Leonid I. Sedov.

Haley, who is known as the dean of space law, arrived in Moscow on May 26th and plans to stay until June 8.

• **IAF Amsterdam meeting**—The Ninth Annual Congress of the IAF, which will meet in Amsterdam August 25-30, will feature simultaneous translations of papers from English to German and German to English.

Dr. Theodore von Karman will deliver the inaugural lecture and will be followed by J. M. Kooy and Eugen Sanger. Dr. Shepherd will chair the first session.

On Thursday, August 28th, delegates will be free to join a sightseeing trip of the Amsterdam area.

"The Law of Outer Space" will be the subject of discussion Friday morning. Thirty-two representatives from ten countries will participate.

Saturday, August 30th, has been reserved for papers from USSR scientists and others, who will be traveling from the International Astronomical Union, to be held in Moscow, August 13-20.

Wernher von Braun to Get Goddard Memorial Trophy

Dr. Wernher von Braun, technical director, ABMA, will be the recipient of the first Dr. Robert Goddard Memorial Trophy at the Dr. Robert H. Goddard Memorial Dinner, to be held the evening of June 6 at the First National Missile Industry Conference.

The presentation will be made by

Wayne W. Parrish, publisher of American Aviation Publications. Selection of the award was made by the editors of MISSILES & ROCKETS magazine for what they consider the greatest achievement during the year of 1957 to advance the missile, rocket and space flight programs of the United States. Text of the award reads in part, "this achievement was the technical supervision and leadership that led to the successful development, testing and accurate flight of the United States' first intermediate-range ballistic missile, the *Jupiter*, and the first U.S. Space satellite."

• **Lockheed award**—Lockheed Aircraft Corporation will be presented with the first missile award by Borg-Warner Corporation at the Robert H. Goddard Memorial Dinner on June 6.

The award is presented "to the organization or company which during the year 1957 in the opinion of the judges contributed most to the advancement of the art of guided missiles or astronautics in the United States of America."

The specific contribution for which Lockheed is being cited is the "remarkable" development of the *Polaris* FBM. Decision to present the award to Lockheed was made by a group of editors prominent in the aviation, missile and astronautics fields.

National Space Program Outlined by NACA Director

Space programs that must be promptly undertaken by NASA (National Aeronautics and Space Agency) under the directorship of NACA (National Advisory Committee for Aeronautics), were recently outlined by Dr. Hugh L. Dryden, NACA director, at a speech before the Tenth Annual California Wing Convention, Los Angeles, Calif.

The proposed space programs, which fall into three groups as presented by Dr. Dryden, are:

1. Projects for development of satellites and space craft such as those used for reconnaissance, which being military operations, would be carried forward by the Defense department.

2. Projects for development of satellites and space vehicles with the special capabilities required by science to probe the secrets of our solar system, which would be the responsibility of NASA.

3. Space projects that will be use-

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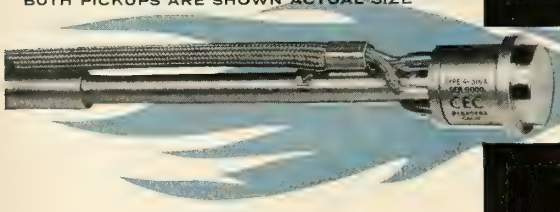
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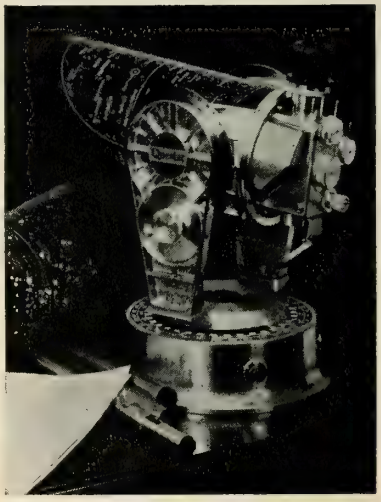
RECOGNIZED LEADER IN GALVANOMETERS—TELEMETRY, PRESSURE AND VIBRATION INSTRUMENTATION

ful for both military operations and the data-gathering needs of civilian science, which will be reviewed jointly by the DOD and the NASA.

Dr. Dryden also discussed the responsibilities of NASA for development, testing, launching and operation of aeronautical and space vehicles. He pointed out that NASA will have to develop new space vehicles, and it would be possible for NASA to build the organization and facilities for space vehicle construction. But, he added, "such action would be very costly and much additional time would be required."

He recommended that design and construction of these space vehicles be performed, on contract basis, at existing facilities. In such cases, sponsorship might be either under NASA or jointly with the DOD.

Optical System Tested At High Altitudes

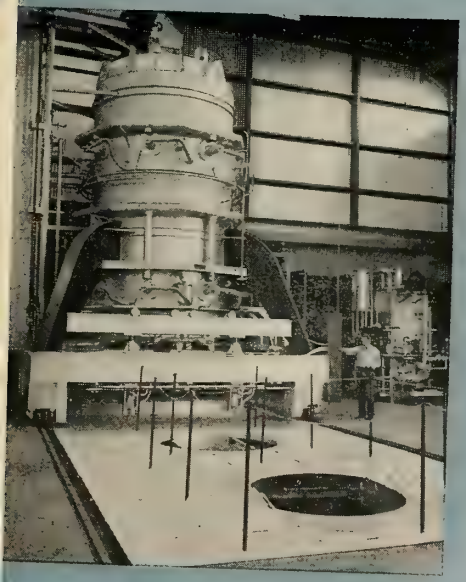


A compact catadioptric (mixed lens-and-mirror system) telescope (with precision optics) took a balloon ride to 40,000 ft. early in May. The telescope was made by the Atlantic Research Corp. of Alexandria, Va. for the Questar Co., New Hope, Pa.

Astronomer Alfred Mikesell and Cdr. Malcolm Ross, physicist, both of the U.S. Naval Observatory and the Office of Naval Research, made the flight with a twofold purpose: for astronomical observations under the superior viewing conditions available at that altitude, and to test new techniques used to record body reactions at the hazards of extreme altitude.

The Questar telescope was chosen for its combination of compactness—

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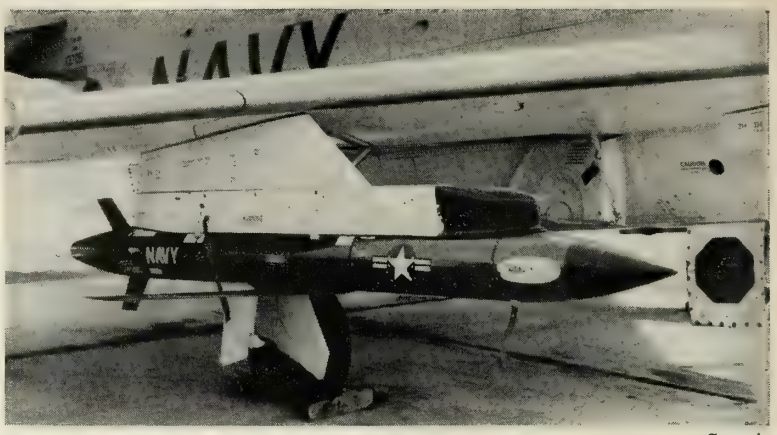
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focal length 42.4 inches, barrel length 8.0 inches—with precision-mirror surface 1/64 wave or better to true spherical. Quartz optics were specified to Atlantic Research, since quartz shrinks less than optical glass.

The telescope accompanied the scientists into the "icebox" at Bethesda Naval Medical Center, Md. (where space medicine research is conducted) to test the effect of −70°F. temperature on the stability of the image.

Although much information was obtained on body reactions to the extreme cold and difficult working conditions, the continual motion of the balloon's gondola made it impossible to take photographs with the Questar. Nevertheless, interesting information was obtained from visual sightings.



Convair

THE XKDT-1 *TEAL*, a rocket-powered target drone developed by Temco Aircraft Corp., is being readied for flight. The drone is evaluated as a new target to provide fighter pilots with a speedy, low-cost target. Shown here, last-minute preparations are made before the *Teal* is attached to an F3H-2M plane for aerial launching. The *Teal* approaches the speed of sound, with altitudes up to 50,000 ft. *Teal* is one of family of new U.S. missiles discussed on p. 39 of this issue.

Air Force Space Program To Feature Rocketeers

An impressive program is taking shape for a space symposium to be held November 10-12 in San Antonio, Texas.

The symposium, sponsored by the Air Force School of Aviation Medicine, Randolph AFB, will feature top figures in U.S. satellite and rocket research. Among them will be:

Dr. Hugh L. Dryden, director of the National Advisory Committee for Aeronautics; Dr. Joseph Kaplan, U. of California physicist and head of the U.S. IGY National Committee; Dr. Fred L. Whipple, director of the Smithsonian Astrophysical Observatory; Dr. James A. Van Allen, U. of Iowa rocket authority on high-altitude research; Dr. Gerard P. Kuiper, U. of Chicago astronomer and specialist in planetary atmospheres; Dr. J. Fred Singer, U. of Maryland space expert on flight and satellite operations; and Dr. Ernst Stuhlinger of the Army Ballistic Missile Agency, designer of the *Explorer* satellites.

The program will feature specialists in every aspect of space exploration, with emphasis on man's venture beyond the Earth's protective atmosphere, and the necessary conditions for his survival. Data collected from intensive study of the cosmos, during IGY, also will be presented for the first time.

Co-chairmen of the symposium are Maj. Gen. Otis O. Benson Jr., commander of the School of Aviation Medicine, and Dr. Hubertus Strughold, Research Advisor and founder of space medicine.

Urge Tax Credit for Research, Development

A plan which would give corporations a direct credit on their federal taxes, amounting to 35% of the amount they spend on approved research and development of products and services, has been advanced by H. Leslie Hoffman, president of Hoffman Electronics Corp.

Hoffman said that the plan would help create a $600 billion gross national product.

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Jupiter-Vanguard Rocket To Launch 1-Ton Satellite

Army has proposed to Advanced Research Projects Agency that a *Vanguard* first-stage engine be mounted atop a *Jupiter* in order to place a one-ton satellite in orbit around the earth. This is one of several Army programs now being considered by ARPA.

This proposal differs from the Air Force's *Thor-Vanguard* in that AF is using the second and third stage engines of *Vanguard*, while Army proposes to use the General Electric first stage engine, rated at 27,000 sea-level static thrust.

Small Size, Low Cost Target Missile Developed

Aeronca Manufacturing Corp. has announced development of a low-cost target missile, said to be half the size of comparative designs.

The propulsion system uses liquid fuel which "is as simple as a solid fuel propellant and in many ways safer," according to the company. The missile is fueled at the factory and is ready for launching upon delivery.

Ground-launched by a zero-length launcher, the missile is said to operate at a sea-level performance of Mach 1. It requires no "cooperative equipment" aboard operational weapons, which utilize the missile as a target.

The system provides miss-distance information which is unaffected by speed, configuration attitude or atmospheric conditions, according to a company official. Gross weight is given as 366 pounds.

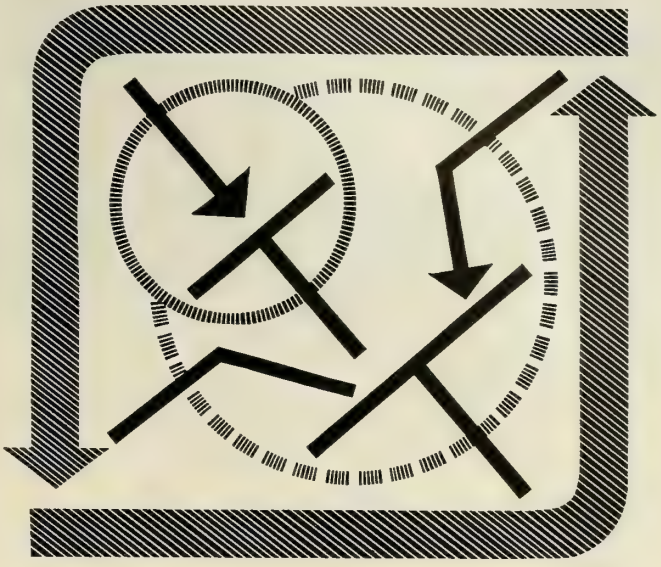
Army Moon Rocket Program, Designated Juno-II, OK'd

The Defense Department has approved the Army's *Juno-II* program for placing one 130-lb. satellite in orbit and firing two lunar probes before Christmas.

Juno-II is based on the same engineering approach as that employed with *Jupiter*-C, except that the *Redstone* first stage will be replaced by a modified *Jupiter* IRBM. Chrysler Corp. is prime production contractor on both *Jupiter* and *Redstone*.

In addition, the second, third and fourth stage arrangement of the clustered solid propellant rockets will probably be altered as to how many of what size solid rockets are used.

Present plans are that all three of these vehicles will be completed and fired before the end of the current calendar year. Defense Department has approved the preparation and firing of



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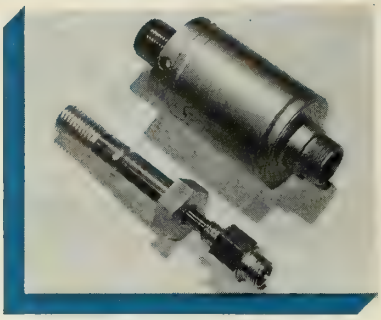
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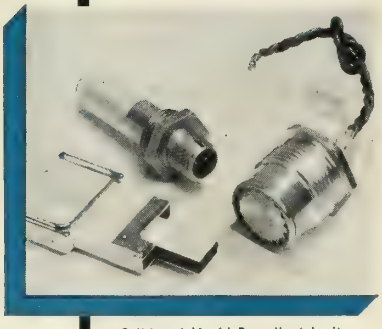
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. . . news and trends

three of the vehicles very soon.

Juno-I is the official Army name given to the current *Explorer* satellite series. Word *Juno* was decided on because with the German pronunciation of "J," the word becomes "you-know." Major responsibility for *Juno-II* rests with ABMA and Jet Propulsion Laboratory.

Air Force's Moon Rocket Has Second Stage Trouble

The second stage of Project *Able*, Air Force's *Thor-Vanguard* hybrid, did not fire at all during the recent unsuccessful shoot from Cape Canaveral. Project *Able* is the Air Force's early moon rocket project, geared for an attempt before the end of the year. Some reports claim that an attempt will be made to hit or orbit the moon on July 4, 1958.

The *Able* rocket consists of a *Thor* first stage topped by the second and third stages of *Vanguard*. *Thor* is the Air Force's Douglas-made IRBM. *Vanguard* is the Navy's satellite launching rocket. The Martin Company is the systems contractor, with Aerojet-General Corp. being responsible for the second stage and Grand Central Rocket Co. supplying the third stage motor. In the recent shoot, the second stage failed to ignite after burnout of stage one.

AMF Finally Purchases Green Mountain Site

American Machine & Foundry has now bought the last of 2,700 acres of land constituting "Green Mountain" just outside of Huntsville, Ala. The land actually was purchased by the Huntsville Industrial Expansion Committee to preclude any knowledge of whom the land was being acquired for, and in order to assure that it was bought at a "fair and equitable" price.

HIEC then turned the land over to AMF at cost. This puts AMF in good position to go ahead with its oft-considered plans to mine the mountain, which is solid limestone, and to further go ahead with the proposed operation of an underground factory—in the halls and passageways excavated during the mining operations. This latter proposition is even more of a likelihood, now that the Army Ballistic Missile Agency has abandoned a similar proposal on the grounds of Redstone Arsenal.

AMF is currently interested in various kinds of ground support equipment, electromagnetic research and other missile and missile-related activities.



Genisco G-Accelerators play vital role in ICBM development

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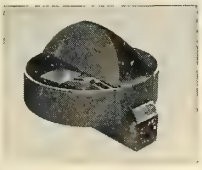
Testing components and complete asssemblies to simulated operational G-forces, as required by MIL-E-5272A, before relying upon their operation in actual flight is easily accomplished with Genisco's G-Accelerators.

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Reds Build Interim Missile/Sub Fleet

Seagoing Missile Among New Developments

by Frank G. McGuire

The Soviet Union today has a missile-armed submarine fleet which could unquestionably inflict great damage directly on the continental United States. Naval intelligence has reportedly learned that Russia has been able to completely waterproof its seagoing missile *Comet* II, for towing behind conventional submarines. According to reports, each submarine tows three missiles and a launching canister.

The *Comet* II, a medium range ballistic missile, has a solid-propellant rocket motor with thrust estimated at 99,000 lbs., and is currently in production. Since it is not possible for this missile to reach all sections of North America, it is considered to be a stopgap weapon until development of the 1,800-mile *Comet* III, which is expected to be completed within the next year to eighteen months. *Comet* III is presently undergoing testing.

[Some experts have indicated that *Comet* III is an air-launched "standoff" weapon, but most data seems to establish its seagoing role. Again, it may be merely a matter of differing designations.]

• **Performance**—Launching of the *Comet* II, utilizing the new method, is accomplished by loading the missile into the cannister like a shell into a mortar tube. The after-end of the cannister is flooded to tilt it into a vertical position, and gyro stabilizers then maintain the cannister in a relatively steady position.

Actual firing of the *Comet* II is then undertaken much as in our own *Polaris* system, i.e., the missile is tossed clear of the launcher and its solid propellant motor is immediately ignited. *Comet* II is understood to have radio-inertial guidance.

Depending on the extent to which this system is now in operation, the Soviet submarine fleet poses a far greater threat to the United States than the German U-boat fleet ever did. Generally-accepted estimates place the number of Soviet submarines at about 600, with a high rate of construction constantly increasing this number.

Despite the fact that most of the fleet consists of W-class, or World War II boats, adoption of the new *Comet* II launching system could enable most of these fleet type vessels to launch operational missiles having considerable range.

Immediately after the end of World War II, Soviet naval authorities realized the potential value of missile-armed submarines and pushed for development of such a system.

The Germans had conducted a few test launchings, using the V-2 submersible canister, and considered the system to be usable, though not yet perfected. The floats, plans, and missiles themselves fell into Soviet hands at the end of the war. The entire system had been located at the Schichau shipyard at Elbing in East Prussia.

German developers of the undersea launching system estimated that one submarine could tow three V-2 launching containers, weighing about 500 tons each, for 30 days at an average speed of 12 knots.

• **J missiles**—The J-series of missiles, which resulted from great improvements over the German V-1 "Buzz Bomb", was subsequently put into interim service with the Red Fleet. The J-1, now obsolete, is pulsejet-powered and boosted by two solid-propellant rocket motors. Its speed is over 500 mph and its range in the vicinity of 375-400 miles.

It has since been succeeded by the J-2 and J-3, each of which has increased range and speed over the J-1, but none of the J-series is believed to have a range of over 550 miles nor speed greater than 875 mph.

Due to the inability of the J-series to reach the interior areas of North America, military necessity has compelled the development of long-range ballistic missiles. The *Comet* and *Golem* series are designed to enable submarines standing off either coast to reach every part of the continent.

It is therefore thought unnecessary, in a sense, to strive for ranges greater than 1,800 miles in a submarine-launched missile since no part of the United States lies more than 1,800 mile from open seas. The *Comet* III should, therefore, be the Soviet equivalent to our *Polaris* FBM.

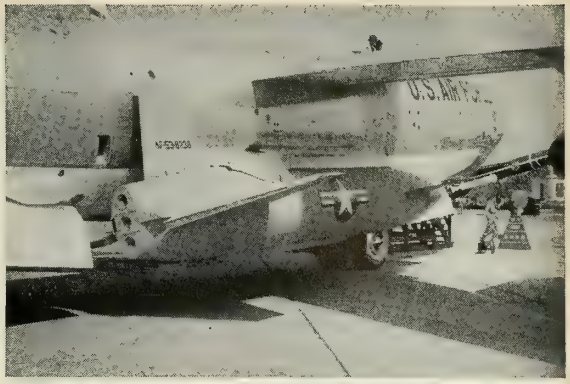
Our own Navy is believed to have considered waterproofing the *Polaris* FBM but abandoned the idea.★

SOVIET MISSILES ADAPTABLE TO SUBMARINE LAUNCHING

Model	Range (Miles)	Length (Feet)	Diameter (Feet)	Thrust (Pounds)	Powerplant	Status	Remarks
J-1	375-400	27	20.6 (Wing span)	1935	PJ & 2 SPR	Obs.	520 mph top speed.
J-2	525	36.5	23.6 (Wing span)	4850	TJ & 2 SPR	Exp.	645 mph top speed.
J-3	450	37.1	23.6 (Wing span)	14,950	TJ (or RJ) & 4 SPR	Pre-Prod.	875 mph top speed.
Golem-1	395	53.8	5.41	121,000	LPR	Obs.	Oxygen & alcohol fuel.
Golem-2	1250	57	7.2	220,000 (1st Stage) 72,000 (2nd Stage)	LPR & SPR	Test	Solid-propellant booster, liquid-propellant sustainer, (acid fueled). Underwater-launch.
Golem-3	7.5	17.1	5.9	14,950	4 SPR	Exp.	Experimental prototype accounts for very short range. Used for research in extreme-depth launchings to 650 ft.
Comet I	100	36.7	4.3	53,250	SPR	Exp.	Also designated CH-17.
Comet II	625	42.3	5.9	99,000	SPR	Prod.	Waterproofed for towing behind WWII-type submarines. Also designated CH-18.
Comet III	1800	n.a.	n.a.	220,000 (?)	SPR	Test	Soviet equivalent of Polaris.
T-7A	50	25	3	18,000	SPR	Oper.	Succeeded by Comet I.

ABBREVIATIONS: Obs.—Obsolete; Exp.—Experimental; Prod.—Production; Oper.—Operational; PJ—Pulsejet; TJ—Turbojet; RJ—Ramjet; LPR—liquid propellant rocket; SPR—solid propellant rocket; n.a.—not available.





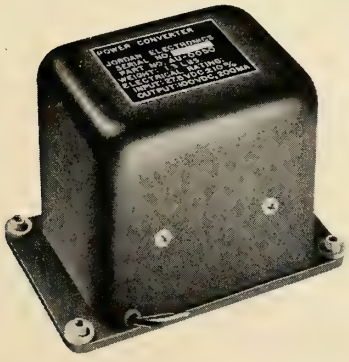
ARMED FORCES DAY in Washington, D.C. was primarily a day for missiles. Army, Navy and Air Force, in a display at Andrews Air Force Base just outside of Washington, showed the hardware with which American will fight another war, if it should be forthcoming. Above are a line of Army missiles with *Nike Hercules* in the foreground, then *Jupiter, Redstone, Honest John,* etc. And, tucked up against the lower fuselage of a B-47 Stratojet bomber, is the Air Force's air-to-surface missile as it will be carried in combat.



SUBSTANTIAL SAVINGS in fabrication and tooling costs on the *Terrier* surface-to-air guided missile, in production for the Navy, are expected to result from a new "batch process" chemical milling facility. Shown here, a *Terrier* part is being checked after masking compound has been stripped away. The etching process is ideally suited to *Terrier's* difficult contour relief production problems.

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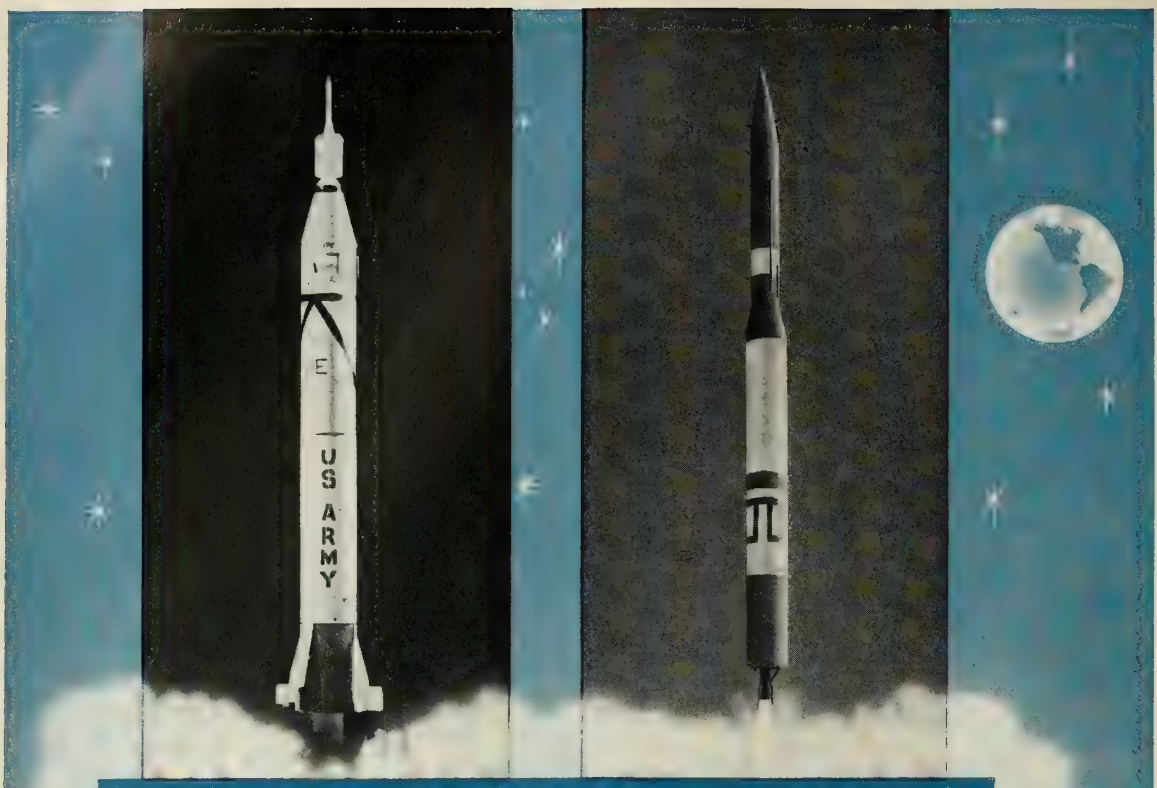
Input: 27.5 V ± 10% (available from 12 to 30 V).
Output: 100 V (available from 6 to 300 V).
Regulation: Line & load ± 1%; Temperature, line & load ± 5%.
Ripple on output: 1 V peak to peak at 2 KC or less.
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Telemetry Key to Missile Operation

Some Systems Now In Use—And a New Approach That May Lead To Increased Information Handling Capacity

by Raymond M. Nolan

BY FAR, THE MOST IMPORTANT way to obtain information from missiles while they are in flight is through the technique of telemetry.

Essentially, telemetering can be defined as the measurement of a desired quantity in the missile, conversion of that quantity to an electrical signal suitable for use, transmission of the electrical signal to a collection station, and reconversion of the signal to a form suitable for monitoring or further analysis.

First link in the telemetering chain is a device to measure and collect the information. This device, commonly called a transducer, can take a number of forms. These are:

Variable-Resistance Devices: Units such as these generally feed their information directly into the telemetering transmitter without further amplification. Some of the more common devices are potentiometers, strain guages with a resistance output, and themistors (see m/r April 1958, page 213.)

Thermocouples: These devices measure by means of recording differences in output between two dissimilar pieces of material.

Variable-Reluctance Devices: Variations in these units are commonly used to cause frequency changes in an oscillator circuit.

Other well-known types are piezoelectric and thermoelectric transducers, manometers, and variable capacitance units.

The next section of the telemetering system accepts the transducer outputs and shapes them into a form which is suitable for radio transmission to the ground link.

Although there are several types of sub-systems in service, the continuous FM/FM (FM-modulated, FM-carrier), the PWM/FM/FM (Pulse-Width modulated, FM-carrier), and PAM/FM/FM (Pulse-Amplitude-modulated FM-carrier) are used most.

• **Sending devices**—FM/FM is basically a scheme where the quantities measured by the transducers are converted into, or used as electrical signals which deviate the frequency of sub-carrier oscillators. The various sub-carriers, in turn, frequency-modulate an RF carrier. Frequency modulation is used throughout because of its freedom from noise (amplitude deviations), and suitability to miniaturization and compact packaging.

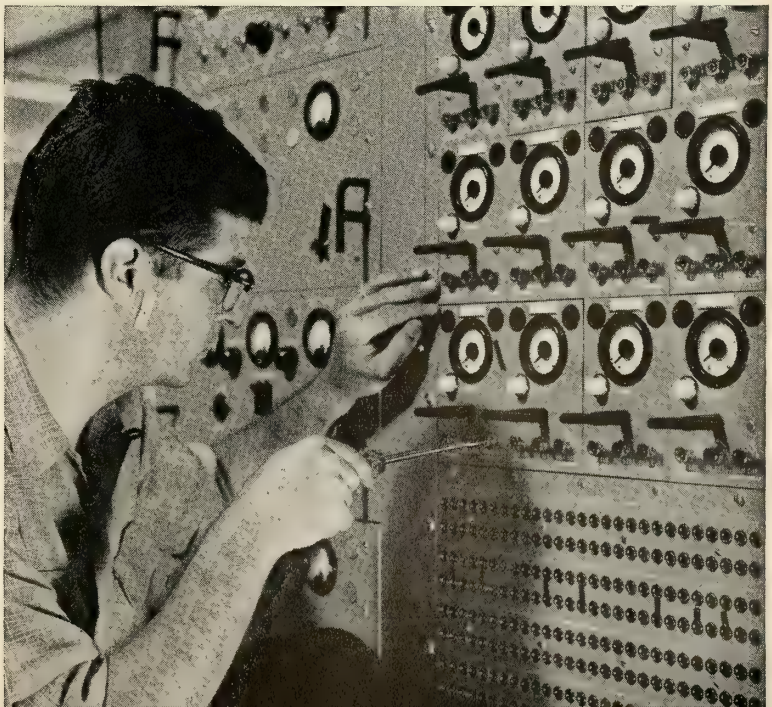
A type of sub-carrier oscillator, the voltage-controlled oscillator, was described in some detail in the February issue of m/r (page 129). The considerations for ruggedization and miniaturization were discussed by the author.

There are two basic uses for sub-carrier oscillators. One is for continuous operation where high-quality information is desired; the other for intermittent sampling through a commutation device where the number of *types* of information desired exceeds the requirement for extreme resolution.

Commutation of signals means that the total number of information channels is increased directly as the number of available channels in the commutator itself.

The signals from the transducers

PULSE AMPLITUDE MODULATION decommutation station at GE's MOSD facility.



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are usually fed into a signal converter, which changes them to a form suitable for use and then applies them to the commutator or directly to sub-carrier oscillators (where continuous sampling is required).

The signals that go to the rotating commutator are impressed on the proper legs, and the commutator feeds them to a gate at proper intervals.

The commutator actually has several functions: As it rotates, it provides excitation voltages to the transducers in order of use, delivers a master synchronization pulse to the gate, and also delivers the gating impulse.

The gating device maintains a constant width between pulses by electronic means, and operates on the information pulses with multivibrator and cathode follower circuits to obtain the sub-carrier oscillator inputs.

• **How they work**—In the transistorized voltage-controlled oscillator described in the February issue of m/r, (p. 129) the voltage across the tuned circuit is 90° out of phase with the current in the loop.

During alternating half-cycles, the circulating tank current passes through the emitter-to-base diode of a modulator transistor, and during the remaining half-cycles, passes through a diode.

A dc control-signal current is fed into the input terminals and biases the emitter of the modulator transistor by varying amounts. The collector of the modulating transistor will then supply reactive current to the tuned circuit, causing a shift in the oscillator frequency.

The sub-carrier oscillator outputs are generally mixed and fed into the transmitter unit of the telemetry system. However, in some cases further amplification is introduced before the signals are applied to the input of the transmitter unit.

The transmitter, as mentioned before, uses the sub-carrier oscillator outputs to frequency-modulate its RF signal. The signal is then multiplied and amplified in the conventional manner for transmission to the ground receiving station.

The final link in the airborne portion of a telemetry setup is the antenna.

Almost every type available has been used, ranging from a conventional stub to flush sections on the missile skin. Most test missiles carry stubs or some variation, but production missiles will probably incorporate flush antennas.

• **Reception**—Ground reception of the telemetered signals is by conventional, precision FM receivers, which separate the mixed signal, by means of discriminators, into the original sub-carrier outputs.

Either or both of two processes is then applied to the signals: Direct oscillograph recording where immediate information is required, and magnetic tape recording for future playback or for input to a computing facility.

Usually, tape recording is done simultaneously so that in case of recording equipment failure, a permanent record of the telemetered information is always available.

Another function of the receiving station is the insertion of time-coding, so that accurate time-interval reference is available both on the direct recorder and magnetic tape.

A description of one data-processing and computation center currently in use appeared in the February issue of m/r (page 95.) One of the functions of this center—the processing of analog information recorded on magnetic tape into a form suitable for application to a digital computer—would make use of the raw-data on the receiving station magnetic tapes. In this function, the computing center converts the tape data into digital information on tapes compatible with IBM 704 computer equipment.

• **Converting data**—The conversion system consists essentially of equipment to handle continuous FM, PAM/FM, and PWM/FM telemetered data. It does not decommutate or scale the data, since this can be done during the computation process.

Initially, a time-code translator uses the time signals recorded at the receiver site to generate instructions to the conversion system. In the event of range station time failure, the time-code translator supplies its own time reference.

In the next step, a bank of FM discriminators separate the various subcarrier channels and route them to several places—including an electronic commutator for the continuous FM signals, a low-pass filter for the PAM/FM signals, and a PWM-to-amplitude converter for PWM/FM signals.

The electronic commutator can accept up to five discriminator outputs of continuous FM information and use the signals to present sample data of each channel in cyclic fashion.

The low-pass filter used with the PAM/FM signals is included to block unwanted high frequencies in the information. The pass band effects a compromise between rise time and noise.

Since the volts-to-digits converter accepts signals in the form of a pulse amplitude train, the PWM/amplitude converter is used to change the pulse width train into pulse amplitude form.

Further in the conversion process, signals are fed from the electronic commutator, the low-pass filter and the

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Republic Aviation Corp., Guided Missiles Div.
Ryan Aeronautical Co.
Stromberg-Carlson, Electronics Div.
Sylvania Electronics Systems, Div.-Sylvania Electric Products Inc.
Technical Appliance Corp.
Transco Products, Inc.
Victor Electric Wire & Cable Corp.
Washington Aluminum Co., Inc.

RADIO FREQUENCY OSCILLATORS

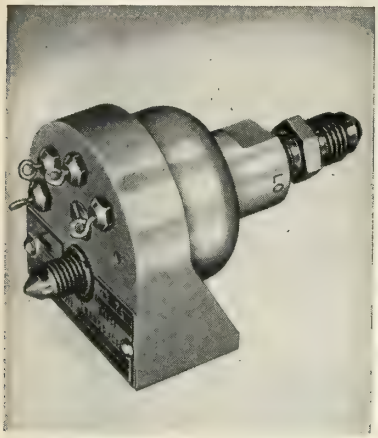
Adler Electronics, Inc.
Airborne Instruments Lab., Inc.
Boonton Electronics Corp.
Boonton Radio Corp.
Consolidated Electrodynamics Corp.
Haller Raymond & Brown Inc.
Hickok Electrical Instrument Co., The
Interelectronics Corp.
Johnson Electronics Inc.
Kay Electric Co.
Manson Laboratories, Inc.
Ralph M. Parsons Co., The, Electronics Div.
Seeburg Corp., The
Tel-Instrument Electronics Corp.
Terminal Radio Corp.
Thompson Products, Inc.
Wave Particle Corp.
Weinschel Engrg.

R-F

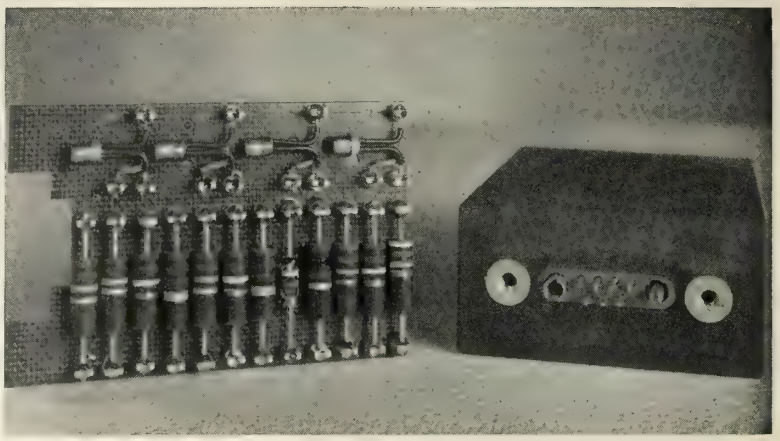
Adler Electronics, Inc.
Airborne Instruments Lab., Inc.
Alpha Instrument Co.
Boonton Electronics Corp.
Boonton Radio Corp.
Consolidated Electrodynamics Corp.
Cooper Development Corp.
Cubic Corp.
Diamond Antenna & Microwave Corp.
Electronic Communications, Inc.
General Communication Co.
Haller Raymond & Brown Inc.
Hickok Electrical Instrument Co., The
Instrument Motors
Interelectronics Corp.
E. F. Johnson Co.
Johnson Electronics Inc.
Kay Electric Co.
Manson Laboratories, Inc.
Munston Mfg. & Service, Inc.
Ralph M. Parsons Co., The, Electronics Div.
Polarad Electronics Corp.
Seeburg Corp., The
Technical Oil Tool Corp.
Tel-Instrument Electronics Corp.
Telonic Industries, Inc.
Terminal Radio Corp.
Wave Particle Corp.

TRANSMITTERS

Acoustica Associates, Inc.
Advance Industries, Inc.
Aircraft Armaments, Inc.
Amelco, Inc.
Collins Radio Co.
Communications Co.
Cubic Corp.
Du Kane Corp.
Electronic Communications, Inc.
Electronics Development Co., Inc.
General Electronic Labs., Inc.
General Railway Signal Co.
Haller Raymond & Brown Inc.
Hazeltine Electronics Div.-Hazeltine Corp.
E. F. Johnson Co.
Lane Electronics Mfg. Corp.
Manson Laboratories, Inc.
Motorola Inc., Military Marketing Div.
Munston Mfg. & Service, Inc.
National Electronics Laboratories, Inc.
Pacific Div.-Bendix Aviation Corp.
Ralph M. Parsons Co., The, Electronics Div.
Radiation, Inc.
Reeves Instrument Corp.
Republic Aviation Corp., Guided Missile Div.
Resdel Engrg. Corp.
Ryan Aeronautical Co.
Sarkes Tarzian, Inc.
Seeburg Corp., The
Skiatron Electronics & Television Corp.
Stavid Engrg., Inc.
Stromberg-Carlson, Electronics Div.
Sylvania Electronic Systems, Div.-Sylvania Electric Products Inc.
Telechrome Mfg. Corp.
Telectro Industries Corp.
Tele-Dynamics Inc.
Terminal Radio Corp.
Westinghouse Electric Corp.
Wunderlich Radio Co.



HIGH RESOLUTION type Bourdon-tube transducer, one of many new products.



TYPICAL voltage-controlled sub-carrier oscillator unit developed by Shepard Instrument Company. Photo shows transistorized unit before and after encapsulation.

PWM-amplitude converter to volts-to-digit converters. Then the amplitudes of each sample are converted to parallel data codes for recording by the digital recording units—the last devices in the conversion link.

The volts-to-digit converter also interjects codes for bad data, data present, time, time code present, and frame synchronization. Versatility here is an important factor.

The digital recorder units accept synchronous data codes and time codes suitable for IBM 704 use, and introduce the final information which must be included on the digital tape before use in the General Electric computing facility.

This system, while not typical, includes most of the elements necessary for converting raw data on magnetic tapes into data suitable for the digital processes. Only through the use of digital computers can the necessary exhaustive analyses be made.

No attempt will be made here to describe the variety of computers available to process the data, but most units fall in the unclassified area and performance specifications are readily available from the manufacturers.

The accompanying tables list a number of manufacturers who make various types of telemetry equipment, but a complete list would probably require two or three times as much space because of the large number of manufacturers who are directly or indirectly connected with this field.

• **Data collection**—A new approach to a not-so-new problem has recently been suggested by Consolidated Electrodynamics Corp. Their suggestion—a PLEXICODER for pulse-duration modulation (PDM) and multiplexing.

The problem is this: more and more telemetered information is wanted, but the collection and time-sharing of this information has had several obstacles.

The transducers that could provide the information needed within the environmental limits specified were generally of the "low-level" time and produced only a few millivolts as an output. Efforts to time-share the information by use of a commutator was found to be impractical. Until recently, several approaches to the problem were in general use.

First of these, of course, was the potentiometer-type transducer, with a voltage output capable of modulating the sub-carrier oscillator directly. But many engineers feel that these devices had just about approached the limits of their use.

Another approach uses amplification of low-level output. But ampli-

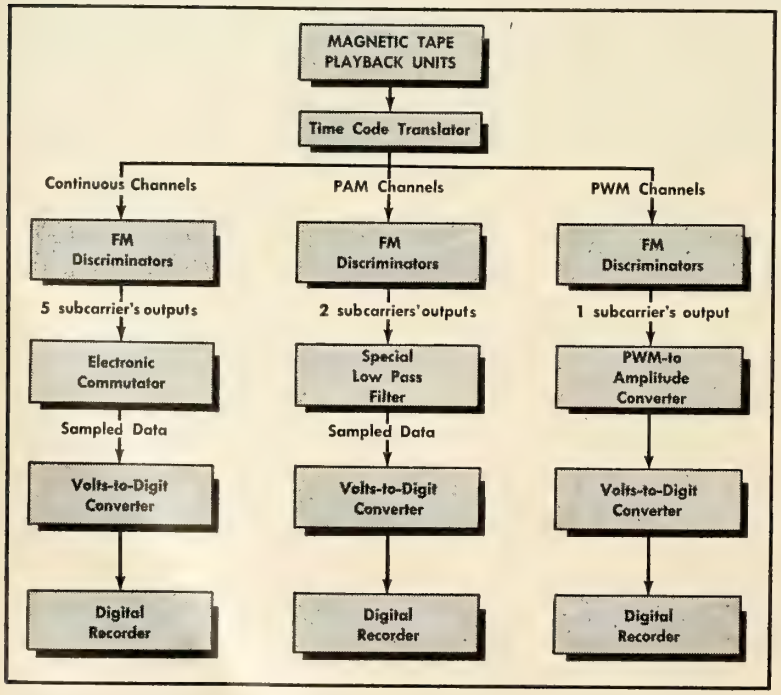
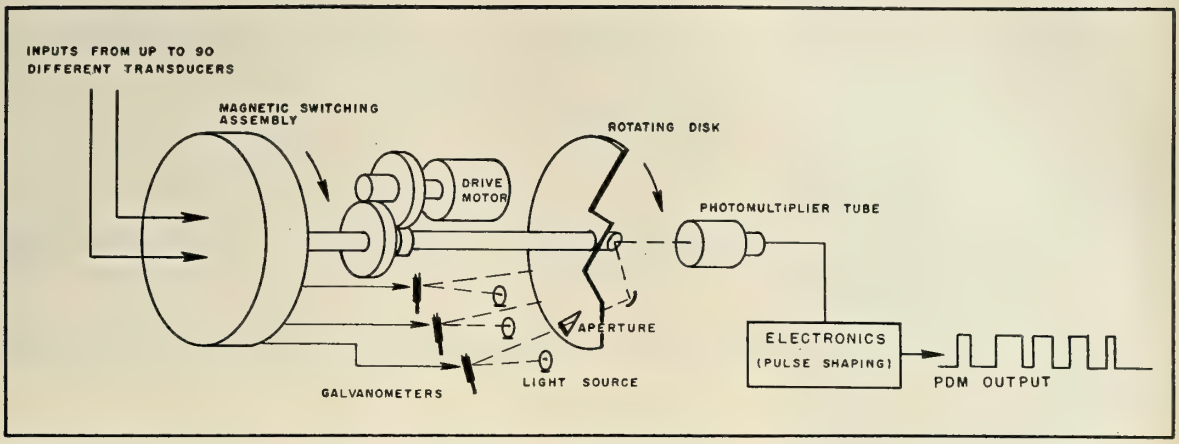


DIAGRAM of analog-to-digital conversion system used by GE's MOSD data center.



SCHEMATIC DIAGRAM of Consolidated Engineering's PLEXICODER PDM commutator. Unit uses light source.

fiers are expensive, and regardless of their refinement, contribute to the overall system error. They also require more power and add weight to the telemetering equipment.

Low-level commutation immediately reduces size, weight, power requirements, and cost. However, it has not proved to be too practical because of the rather limited number of channels which can be used. Commutation rates of PDM systems exceed the handling capabilities of mechanical commutators for low-level signals.

• **Unit description**—The PLEXICODER uses recording galvanometers and achieves high-speed commutation and conversion to PDM by interupting a light beam. The unit can handle 90 channels.

Each input signal is fed through two hermetically sealed, magnetically operated switches—which act as a double-pole, single-throw switch to a galvanometer.

The unique design of this input switch eliminates induced voltages normally associated with a magnetic switch. These switches are opened and closed in a predetermined time sequence by moving magnets, so that a given galvanometer is energized by a transducer for only a specific time period.

Each galvanometer may accept as many as six different inputs in sequential fashion.

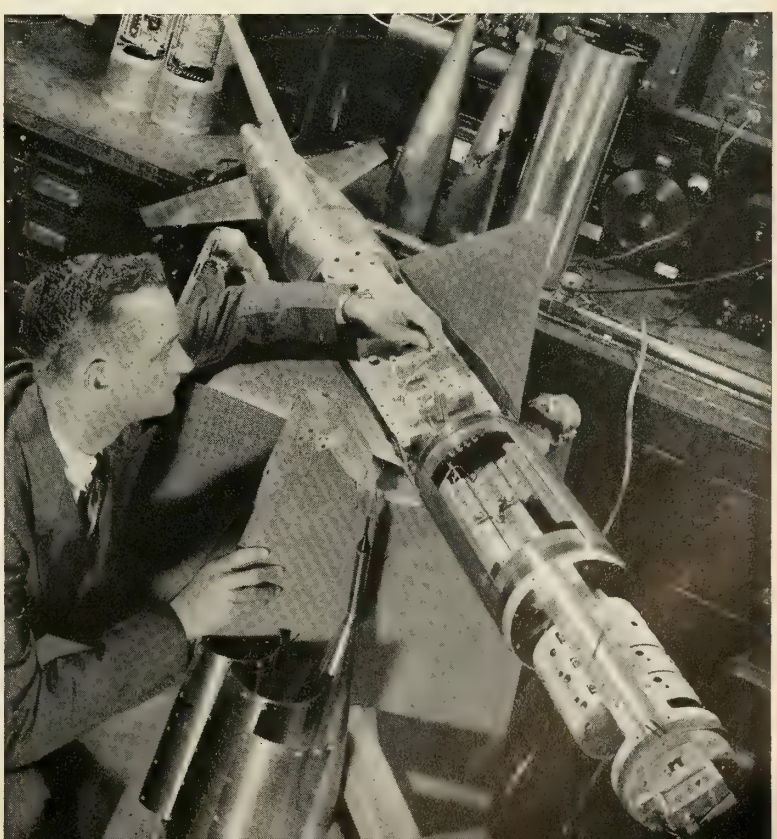
The light beam from the galvanometer passes through an aperture, cut in the shape of a right triangle, to a disk which rotates at a constant speed and at a right angle to the light path.

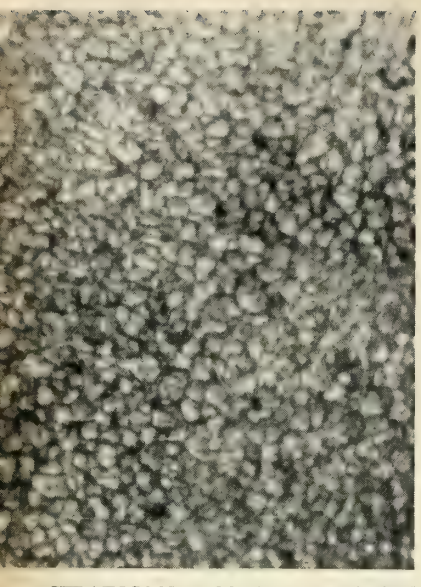
As the aperture crosses the light beam, light is admitted to a photomultiplier tube for a duration dependent on the beam's position along the hypotenuse of the triangular opening.

The beam's position depends on the angular displacement of the galvanometer mirror, which is in turn proportional to the transducer input to the galvanometer coil. As the light beam strikes the tube, a voltage pulse is developed by the tube. The duration of this voltage pulse is a direct linear function of the transducer signal transmitted to the PLEXICODER.

This description is intended to be representative of the current thinking in this field. It also represents the current and future developments which may be expected due to the extreme importance of telemetering.★

RESEARCH MODEL being instrumented at NACA's Langley Aeronautical Laboratory.





STRATOSCOPE SOLAR TELESCOPE photo of sun is far sharper and more detailed than any taken from the Earth.

Optics Move Into Space:

Satellite "Eyes" To View Earth Weather Conditions

by William Strouse*

THE DESIGN AND PRODUCTION of high performance optical systems for use in the upper atmosphere and in space requires the solution of many unique problems. Optical performance is naturally the prime requisite of any system, and weight minimization is always an important factor. Careful consideration of the environmental situation is essential to develop reliable instrumentation for operation under the varied and difficult conditions aloft. Both the Stratoscope telescope and the *Vanguard* Weather Eye described in this article provide examples of the types of problems encountered in the design and construction of optical systems for operation in the upper atmosphere and space.

Astronomy took what may be considered its first move "into space" last fall, under the auspices of Project Stratoscope. A 12-in. aperture telescope-camera, designed and built by the Perkin-Elmer Corp., Norwalk, Conn., was launched to 80,000 ft. by large Skyhook balloons to photograph the sun.

Prior to Project Stratoscope, photographs of solar granulation had been taken from manned balloons at altitudes of 20,000 to 25,000 ft.

As Project *Vanguard* progresses, optics will take real strides into space. "Weather Eye" optical systems, designed and produced for the *Vanguard* program, will be carried aboard the satellite to measure the infrared energy reflected from the earth's cloud layer. These tiny devices will give meteorologists greater quantities of information than now available for weather prognostication.

• **Satellite Weather Eyes**—A beneficial use for earth satellites will be the gathering of meteorological data for weather forecasting. At present, weather forecasts are based on observations covering only 5-10% of the earth's surface.

The Weather Eyes, developed and built by Perkin-Elmer for the U.S. Army Signal Corps Laboratories at Ft. Monmouth, N.J., will implement the first attempts at comprehensive meteorological reconnaissance. Scheduled for the fifth *Vanguard* shoot, the "Eyes" will make possible "mapping" of the Earth's cloud cover. Cloud formations and densities are key indications of forthcoming weather.

Weather Eyes will be used in pairs, mounted back-to-back on the central core of the 20-in. *Vanguard* satellite. They will peer outward in opposite directions through holes in the satellite shell. Their direction of view will make a 45° angle with the axis rotation of the satellite.

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*Project Engineer, Engineering and Optical Division, The Perkin-Elmer Corp., Norwalk, Conn.

VANGUARD'S **"Weather Eye" is designed to measure IR radiation from earth's clouds.**



As the satellite spins in flight, the field of view of one "Eye" will sweep across the earth or its cloud cover, below and forward. The other "Eye" will sweep the area below and rearward during the second half of each rotation.

In this way, the "Eyes" will collect infrared energy characteristics of clouds. In similar fashion to a television raster, an infrared picture of the clouds will be built up by successive sweeps. The "Eyes" will cover some 600 miles wide on a sweep. Satellite rotation will be about one revolution per sec.

The infrared energy will be focused on a one millimeter square Ektron (lead sulfide) detector. The electrical signal from the detector will be recorded on magnetic tape, where it will be stored until it is read-out and transmitted on later command from ground telemetering stations.

The very "fast" f/0.7 optical system makes possible the rapid sweep rate of the projected detector area over the clouds. It also allows a compact configuration which readily fits into the satellite.

With weight limitation of prime significance in the satellite program, the short focal length of the system aids in keeping each Weather Eye one-half ounce under the initial weight limit goal. Each optical unit weighs 3½ ounces.

In order to minimize weight, the cell is made of .010 in. thick stainless steel sheet, type 430. After the sheet is butt-welded into a cylinder, a bead is spun at the front of the cell for stiffening the structure. Near the rear of the cell, a controlled form indentation is spun into the metal to form a seat for the beveled face of the primary mirror.

Type 430 stainless steel, and primary mirror glass type BCS-2, were chosen for an approximate match of thermal expansion. The low-weight method of mounting the primary mirror requires a close fit between glass and cell diameters, and, accordingly, the match of expansion co-efficients.

The primary mirror is bonded into place with Pliobond. Thus, it is permanently "squared-on" and located with respect to the detector cell location. Small variations in location of the focal surface are compensated by shifting the detector to the exact focal area with spaces.

The ribs holding the detector cell are of the same stainless steel, .010 in. thick. These are spot welded to the main cell and silver-soldered to the thinwalled brass detector cell. The entire unit is buffed and given a gold finish to minimize the effects of stray radiant energy.

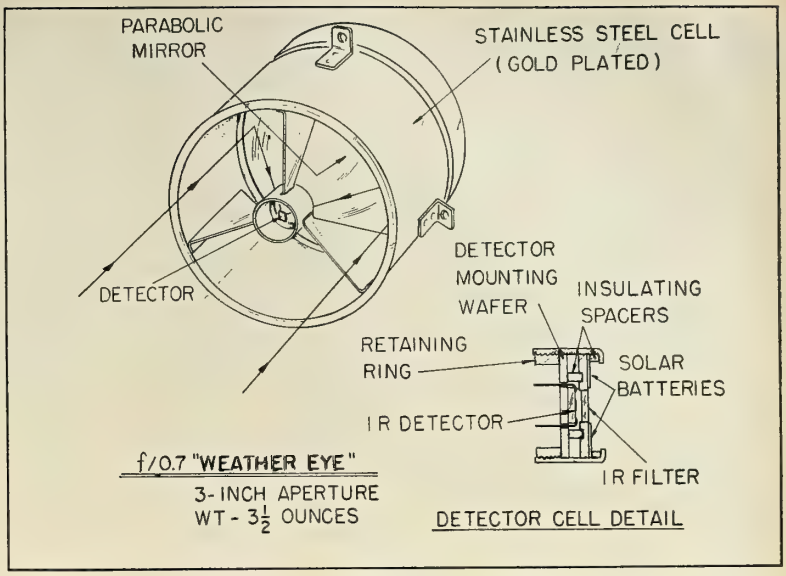
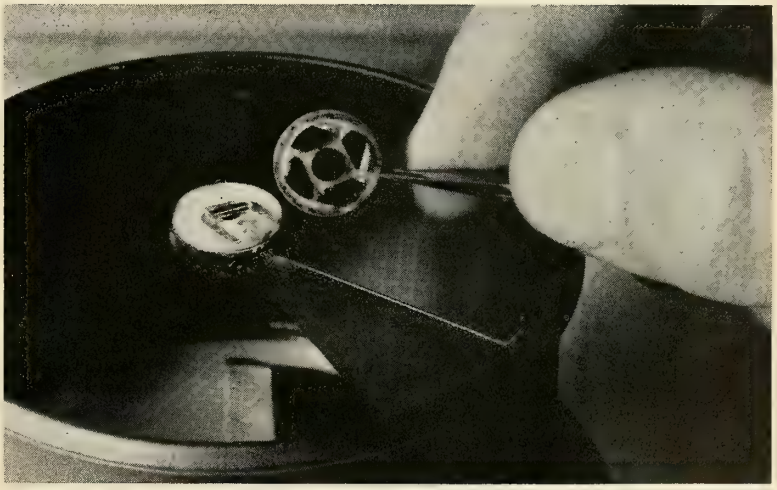


DIAGRAM OF SATELLITE "Weather Eye" with additional details on the detector cell.



SILICON SOLAR BATTERY SYSTEM (black oblong objects in center) are used by the instrument to differentiate between day and night.

An alternate configuration for the Weather Eye was considered, which would have made possible further weight reduction by ½ to ¾ ounce for each unit. It was decided however, that a gain in reliability, i.e., resistance to damage from vibration and acceleration, was achieved by the well braced structure described.

• **Stratoscope solar telescope**—The Weather Eye optical unit is a relatively simple device, however, the Solar Telescope is a more complex optical system. It is part of the complete Stratoscope system involving the support frame, pointing mechanisms and balloon which carries the telescope to high altitudes.

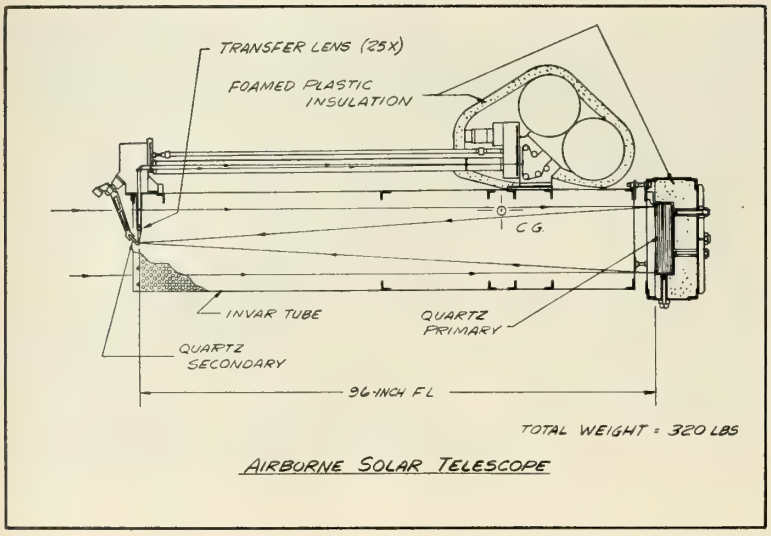
The goal of the Stratoscope project was to obtain photographs of unprecedented resolution of the "granulation" on the solar surface. This would determine which of various astrophysical theories most closely describes the physical reality.

Such detailed photographs cannot be satisfactorily obtained through the earth's atmosphere—the air is in a constant state of image-degrading turbulence, especially during daylight hours.

Under the auspices of the Office of Naval Research and Dr. Martin Schwarzchild, director of the Department of Astronomy, Princeton University, the Solar Telescope made two successful balloon flights in September



FRONT AND REAR VIEW of the assembled satellite "Weather Eye" units.



SOLAR TELESCOPE diagram, developed by Perkin-Elmer for Project Stratoscope.

and October, 1957 to photograph the surface of the sun.

From a vantage point over 80,000 ft., above 98% of the earth's atmosphere, the telescope-camera took 8,000 35mm photographs of the sun on each flight.

The measure of success for the Stratoscope project was to be the attainment of one perfect photograph of the solar surface.

It was expected that the equipment would survive the shock of its first parachute landing back to earth. In the event that it should not, it was mandatory that the telescope and camera perform reliably to obtain one perfect picture on the first flight.

The resolution of detail obtained on film is limited by diffraction of the telescope's 12-in. aperture. The optical elements must therefore be of "perfect" quality, so they cannot cause degradation of image quality. "Perfect" in optical shop practice means conformance of the glass curve to a true paraboloid within one-twentieth of a wavelength of light.

The pertinent features of the telescope are shown in the schematic diagram. The primary mirror is an f/8 paraboloid whose surface does not depart more than one millionth of an inch ($\lambda/20$) from a parabolic curve. The secondary mirror is a flat diagonal which diverts the light 90°.

The doublet transfer lens compensates for the coma of the primary, while magnifying the primary image 25-fold. A small prism diverts the light again toward the camera, where, on 35mm film, a frame size 1 x 1½ in. is exposed. Each photograph covers about one-half percent of the sun's area or roughly 50,000 by 75,000 miles.

• **Project Stratoscope**—The balloon-launched telescope was sent aloft at dawn. An hour, or slightly longer, was required for the balloon to reach its ceiling altitude. By preset timing arrangements, the telescope pointing system was actuated after sufficient time for aerodynamic equilibrium to be achieved.

The telescope was pointed at the sun by the photoelectric-servo system for a period of about an hour to achieve warm-up of the guidance-stabiization circuitry.

Photography began by energizing the telescope-camera motor, and proceeded for slightly more than two hours.

After photography was completed, the telescope was pivoted to a protected position within the support frame and the system returned to earth by parachute.

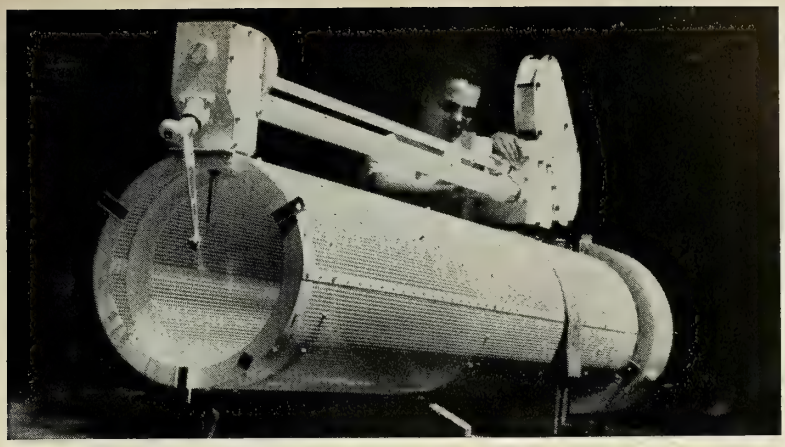
The sun's radiation warms every object upon which it falls—unless the body is a perfect reflector at all wavelengths. The air temperature at 80,000 feet is about −60°C, and the sky above is a radiant energy "sink" of absolute zero.

The combination of these circumstances comprises an environment fraught with potential difficulty for an astronomical telescope. Accurate alignment, constant spacings of elements, and turbulent air currents all require detailed consideration if the highest optical performance is to be achieved.

The primary mirror coating, although of high-reflectivity evaporated aluminum, is not a perfect reflector. Approximately 12% of the sun's radiation is absorbed and causes heating of the mirror. To minimize effects of this heating, the mirror is made of quartz, an optical material of minimum thermal expansion. Changes in the general curvature of the mirror, which cause changes in focal length, are thus kept within negligible limits.

The warming of the mirror's front surface spreads throughout the quartz, and the heat is conducted through the mirror supports to the mirror cell walls. There are localized cooled areas where the supports touch the blank. These heat sinks on the back will result in non-uniform cooling and cause the front surface mirror curve to depart from the 1/20-wave smoothness necessary to achieve perfect imagery.

The thermal conductivity of the



COMPLETED TELESCOPE undergoing final tests at manufacturer's plant.

mirror was reduced to a negligibly low value by making a .25-in. wall, ¾-in. diameter micarta tubing with nylon buttons, which have small (1/8-in. diameter) areas of contact with the mirror. The light structure of these supports served the additional purpose of being easily breakable, so that on a hard landing they would yield and minimize fractures of the primary mirror.

• **Precautionary measures**—The cell was lined with 3-5 in. of foamed plastic, which served the dual purpose of thermal insulation and shock absorption if the mirror supports gave way at landing. The back and edge of the primary mirror were given a "shine" (as opposed to an optically figured polish), and coated with evaporated aluminum to reduce radiation losses from the mirror.

The tube of the telescope establishes the separation of primary mirror and secondary diagonal. This spacing must be accurately equal to the focal length of the primary. Since change in length of the tube could not be tolerated, it was made of Invar, the alloy whose thermal expansion is a minimum for structurally suitable metals.

To minimize effects on the temperature of the tube, it was covered by white paint (titanium dioxide pigment), as were all other exterior parts of the telescope. The tube was perforated, to reduce the weight and minimize disturbance to image quality from air convection by breaking the flow into small eddies.

At the focus of the primary mirror was a Newtonian diagonal mirror. All the energy of the sun that streamed into the full 12-in. aperture was concentrated into a 7/8-in. diameter image for viewing.

If the secondary mirror were to be fixed at this location, it would be badly distorted due to heating, and there would be danger of loss of the aluminum coating from the high temperatures developed. The elements of the system to which energy is transferred by this mirror would also be distorted by the constant stream of energy.

To circumvent these possibilities the secondary mirror was kept in motion and was out of the sun's image 98% of the time. The rotation of the arm holding the mirror was synchronized with the shutter and film transport.

During 2% of the time that the diagonal mirror diverted light to the camera, the film exposure took place. Duration of exposure was determined by a focal plane shutter. Exposure time was 1/1000 sec.

Appraisal of these precautionary design features indicated there was still uncertainty of success toward achieving the one perfect picture of the solar surface. To insure utmost reliability in performance, a further step was taken to be certain of a good picture even if the previous measures stoll allowed shifting of the focus.

The small 25-power transfer lens was traversed axially in a sequence of 20 steps to cover and safely exceed the region of space wherein the focal might fall. The range traversed was 2.5 millimeters. This precaution resulted in purposely losing 19 of every 20 shots. Consequently, of the total of 8,000 negatives exposed, only 400 photographs could be good.

The film was protected from extreme cold, which might result in breaking the forces needed to move it through the camera, by insulating covers which conserve heat from the pre-launching environment. The motor which drives the telescope-camera's mechanisms was enclosed by these covers, to utilize the heat developed in the motor.

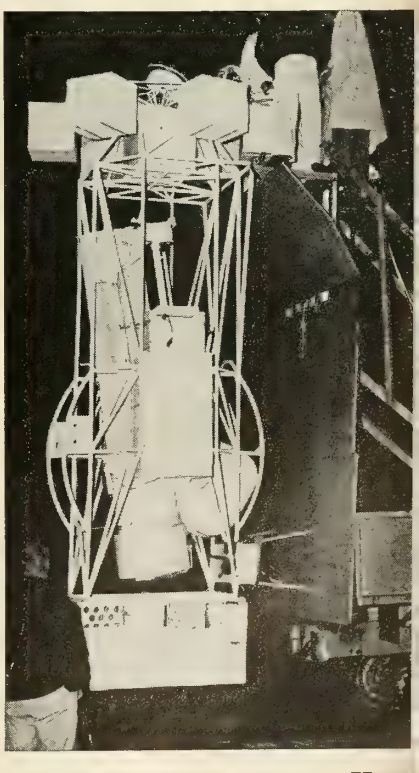
• **Successful result**—The numerous precautions produced a highly successful system. The telescope, after two flights into the upper atmosphere, returned to earth with photographs of unexcelled resolution and with only slight mechanical damage resulting from landing.

The Princeton astronomers plan, in 1959, to fly the Solar Telescope again for further photography of the sun. The pointing will be directed via radio control from a ground station. The area to be photographed will be selected by television monitoring of the field of view of the telescope. Photographs are desired of "special interest" regions, e.g., sunspots, faculae, and solar prominences.

Due to the success of this first effort in extra-terrestrial astronomy, a 36-in. aperture balloon-borne telescope is being planned for use on objects in the night sky.

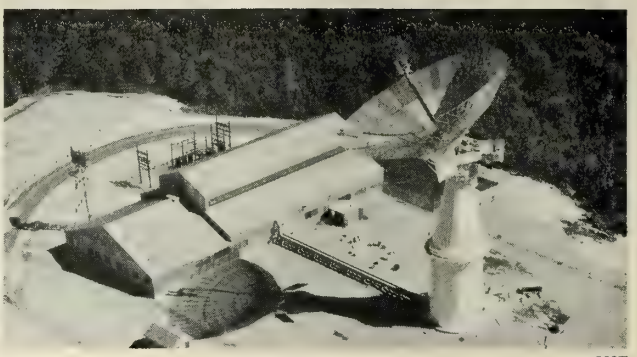
The optical systems discussed above are the forerunners of diverse, more complex, and larger systems of the future. These future systems will embody the same design considerations which have already been proven in systems operation.★

FINAL PREPARATIONS are made just prior to launch. Telescope is seen in its support cradle. Ascending and descending, it was in a vertical position. After attaining ceiling height, a time mechanism lowered the telescope, and photo-electric servo controls pointed it at the sun.



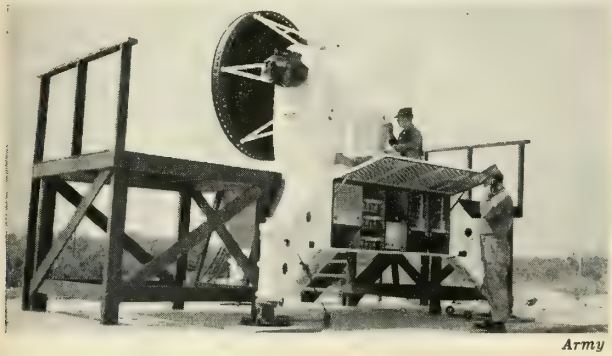


Army

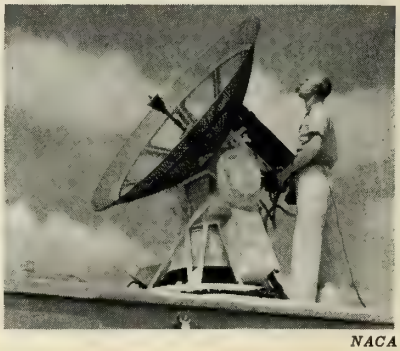


MIT

The Army Signal Corps DIANA moon radar has been used to develop a technique for the testing of *Vanguard* tracking stations. The experimental Millstone Hill long-range radar (right) has an 84-foot parabolic reflector.



Army



NACA

Tracking radar for *Nike* SAM is checked by Army technicians at Fort Story, Va. This is one of two radars used to direct *Nike* in its interception. NACA radar (right) tracks a research model launched from Wallops Island, Va.

RADAR TRACKING

During the flight test phase of every missile program, ground-based radar tracking systems play an unpublicized—but extremely vital—role in recording the missile's performance.

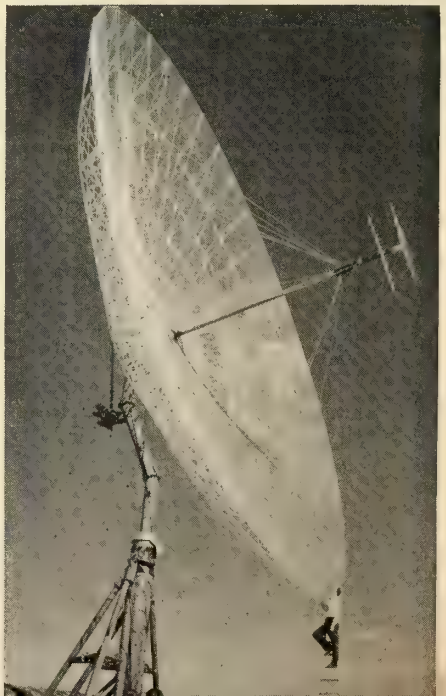
Missile experts know that a rocket's accuracy must be determined in the first few seconds of flight. A small error at the start can mean hundreds of miles of error at the target.

Radar instrumentation requires a tracking and plotting system that can follow a missile through its entire flight path; and at the same time record azimuth, elevation, height, and range position instantly. This requires not only the tracking instruments but a data-transmission and processing system for transcribing in the form of a permanent record, the flight characteristics of the missile.

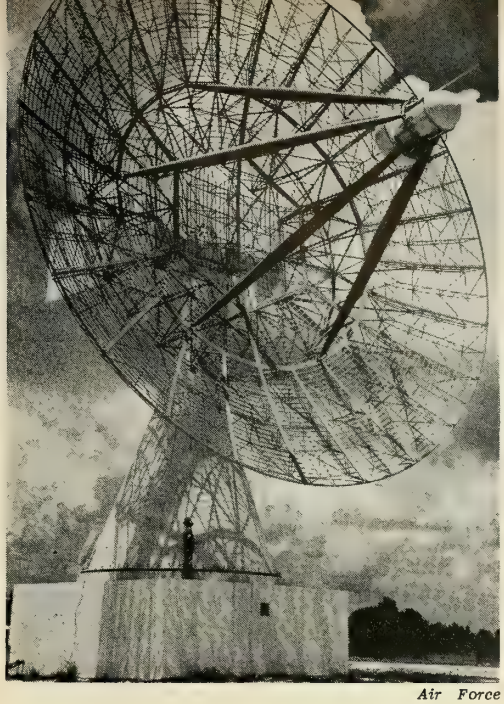
The basic components of a radar tracking system consist of a radar transmitter, a receiver for pickup and amplification of the echo of the transmitted signal, a position indicator for display of range and azimuth data, a data-transmission system for feeding a computer which analyzes and records the data. The size and range capabilities of radar systems vary with the design range and flight performance of the missile.

Stanford Research Institute's 61-ft-diameter radar uses a 100 mc transmitter to gather meteor data.

Air Force



One of five 60-ft-diameter radars used by the Air Force in Florida for missile-tracking work.



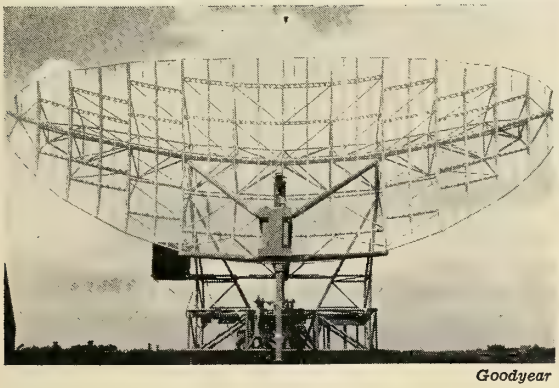
Air Force



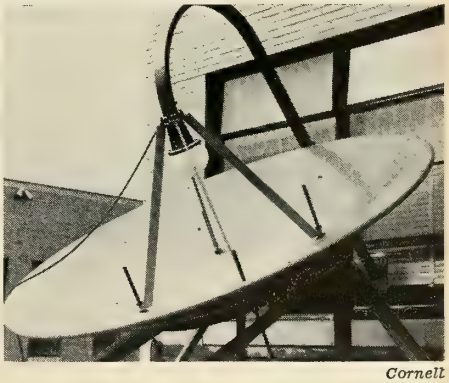
Air Force

Modified radar antennas with bore-sighted cameras track missiles, at Cape Canaveral, Fla.

Part of the nation's air warning system, this 750-sq. ft. antenna was built by Goodyear Aircraft. Eight-ft. microwave antenna dish (right) has been used by Cornell Aeronautical Labs to emit radar signals at 17 million watts.



Goodyear

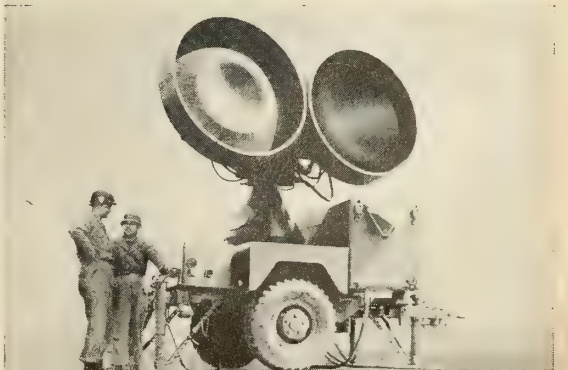


Cornell

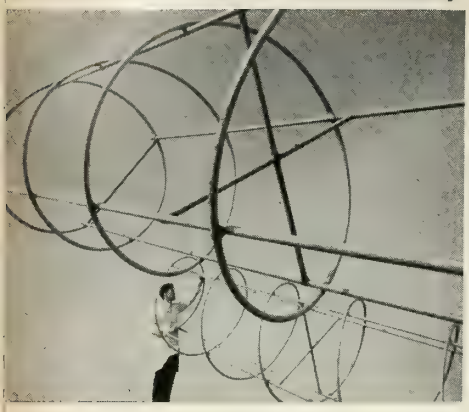
Equipment used to track Army *Explorer* included this Carrier Corp. radar located on the Florida coast. The *Hawk* surface-to-air radar (right) developed by Raytheon, tracks low-flying targets while ignoring stationary objects.

Carrier Corp. *Army*





Ramo-Wooldridge



Doppler radar antenna picks up data on electron density in space 50 miles up and out.

TELEMETRY TRACKING

Depending upon the type of antenna utilized by the missile transmitter and the angle of coverage of the transmitted signal, the types of telemetering antenna needed for ground receiver units are quite varied.

Helical-beam antennas, which are quite efficient for the FM band, are the most widely used. This type of antenna consists of a helix positioner, so that its axis is in line with the source of radiation from the transmitter antenna. At Cape Canaveral and Pt. Mugu long range proving grounds, the equipment is located at mobile temporary sites or installed in the launch pad block houses.

Radar telemetering systems (pulse-position modulation) promise to be the most advantageous for missile research and development programs. Objections to this form of telemetering are the high voltages required, in addition to the sensitivity of the components to changing temperatures and pressures.

Elaborate helix antennas, left, which receive telemetered data from NACA launched research models at Wallops Island. Crudely-fashioned Japanese antennas, for tracking *Baby* rockets, right, are strikingly similar.



NACA



Itokawa

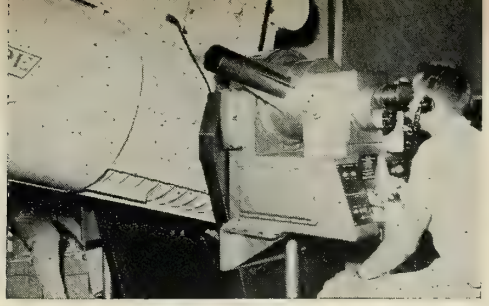
Students study telemetry antenna for *Corporal* on battery control trailer, left. Patrick Air Force Base MK-51 Director with telemetry radar antenna used in tracking missiles during early flight, right.

Army



Air Force

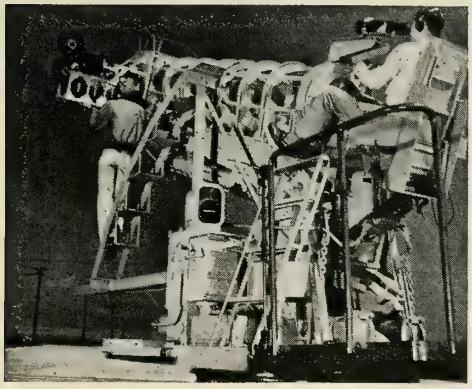




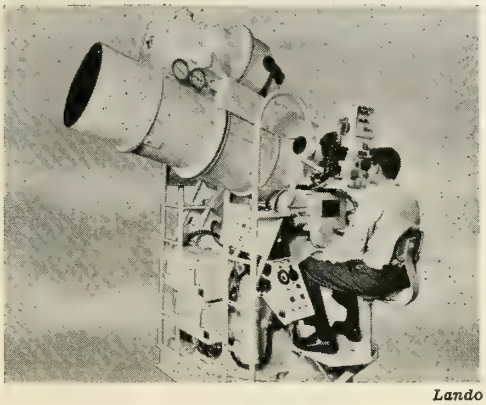


Perkin-Elmer

Operator mans eight-ton Perkin-Elmer Recording Optical Tracking Instrument at Air Force Missile Test Center, left. Unit can be operated remotely. Transportable optical tracking system, right, lines up skyward.



Army



Lando

Sixteen-inch reflecting telescope on 90-mm anti-aircraft gun tracks high altitude rockets at White Sands, left. J. W. Fecker Inc., IGOR (Instrument Ground-based Optical Recording) missile tracking telescope, right.

OPTICAL TRACKING

The elevation, height, azimuth, flight attitude and range during the first few minutes of a missile's flight can be recorded for later evaluation by combining phototheodolites and synchronized telescope cameras. Units now installed at Cape Canaveral can observe and photograph missiles for hundreds of miles. Some phototheodolites are operated in conjunction with radar telemetering equipment, providing a more accurate recording than could be obtained with one of the systems operating alone.

A phototheodolite is basically a motion picture camera equipped with long range lens of high resolution. The shutter is operated by a central timing control that synchronizes shutter action with the telemetering system. Several of the telescopes are located at intervals down range in order to make full flight recordings. The central timing control system assures later identification for any instant of the flight for one continuous data recording.

In addition to the photo record, a continual check on the accuracy of the telemetering equipment is a supplemental advantage of the optical system. On many flights where the telemetering system has failed to operate properly, the optical tracking equipment has saved the day. Optical instrumentation demands a high degree of care and possesses extreme accuracy.

The telescopes range in power from 20 to 30, with a very narrow field of view. Manual control of optical instrumentation is rapidly becoming a thing of the past, due to this narrow field of view. Instruments operated manually are provided with cross hairs for centering the system on the missile.

Camera on 40-mm gun platform tracks missiles to 140-mile height at Holloman Air Force Base.

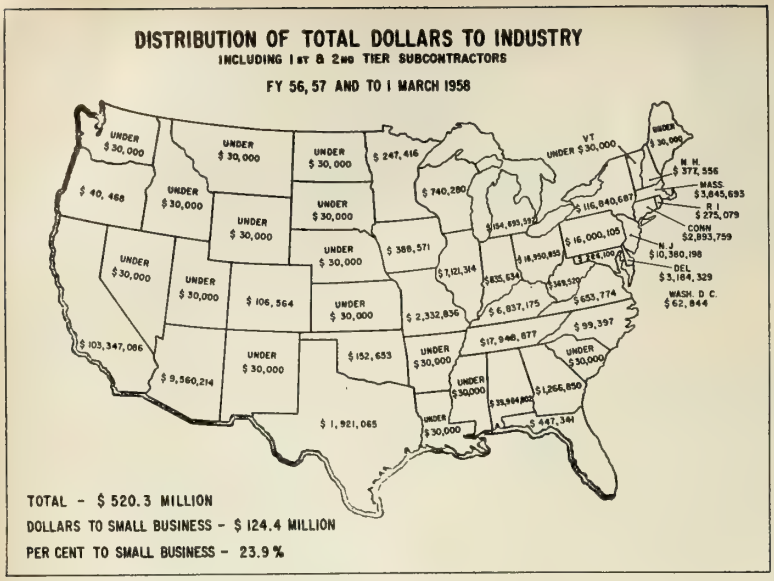


Air Force

IGY satellite tracking camera weighs three tons. Twelve are being placed around the world.

Perkin-Elmer





ARMY'S allocations to small firms show trend as . . .

Congress Takes a Serious Look at:

Small Business Status in Missile Procurement

by Donald E. Perry

THE POWERFUL Senate Subcommittee on government procurement has gone to the defense of the nation's small businessman to determine if he's getting a fair share of the mushrooming procurement dollar for missiles-astronautics.

Recently, this subcommittee, which has delved into all forms of government procurement, for the first time centered its attention on the lucrative astronautics-missile field. Three days of hearings resulted in a majority committee opinion that the potential of small business in missiles-astronautics is getting short-sighted glances from some government procurement quarters, while at the same time:

1. $4 to $6 billion is being spent for missiles and related equipment, and prospects for this procurement indicate that it will soon eat up 50% of the defense budget.

2. The missile industry is coming to the realization that there is no need for production runs totaling thousands of units, requiring acres of plant space, and tens of thousands of assembly line workers.

3. Every dollar spent directly on missile systems demands that $2 to $3 be spent on missile support equipment.

4. Small business is demonstrating that it has the capacity to handle imaginative projects in a matter of minutes with considerable savings.

The leading question in the minds of the subcommittee was the present status and future of small business (less than 500 employees) in missiles-astronautics.

• **Present status**—Today, according to Defense Department figures, small business is averaging 20% of every dollar spent on missiles-space procurement.

Whether this is a fair average or not, the Small Business Administration doesn't know—there are too many intangible factors. However, SBA points to a Navy estimate that about 40% of all Navy procurement goes to small business.

Small business gets the bulk of its missile-space dollar through subcontracting. SBA's so-called gripe is that many areas of small business capability —for prime production, research and development—are not being exploited.

Another complaint by SBA is that service contracting officers are inclined to give prime contracts to a select few. One investigating Senator put it this way: "Small business often has to go to the prime contractor, hands extended, bow three times in the right direction, and just maybe, may become a subcontractor."

In fiscal year 1957, for example, the Army gave only 4.5% of its prime contract dollar to small business; the Navy less than 3%; and the Air Force, eight-tenths of 1%. The same year, small business received only 4.3% of the total dollar value of research and development prime contracts.

Army statistics show that of 46 R&D prime contracts, 25 production contracts (well over 50%) went to the firms—mostly big business—who had handled R&D.

• **Future status**—In fiscal year 1958, with missile spending at an accelerated rate, small business apparently is faring worse. Small firms received only .8% of prime contracts during the first half of 1958, while in fiscal year 1957, they received 1.9%. Stepped up R&D activities in fiscal year 1958 have failed to bring an improving status to small business in prime R&D contracts, the committee learned. Awards for the first eight months of 1958 amounted to $1.9 billion, an increase over the same period of 1957 when $1.8 billion in contracts were awarded.

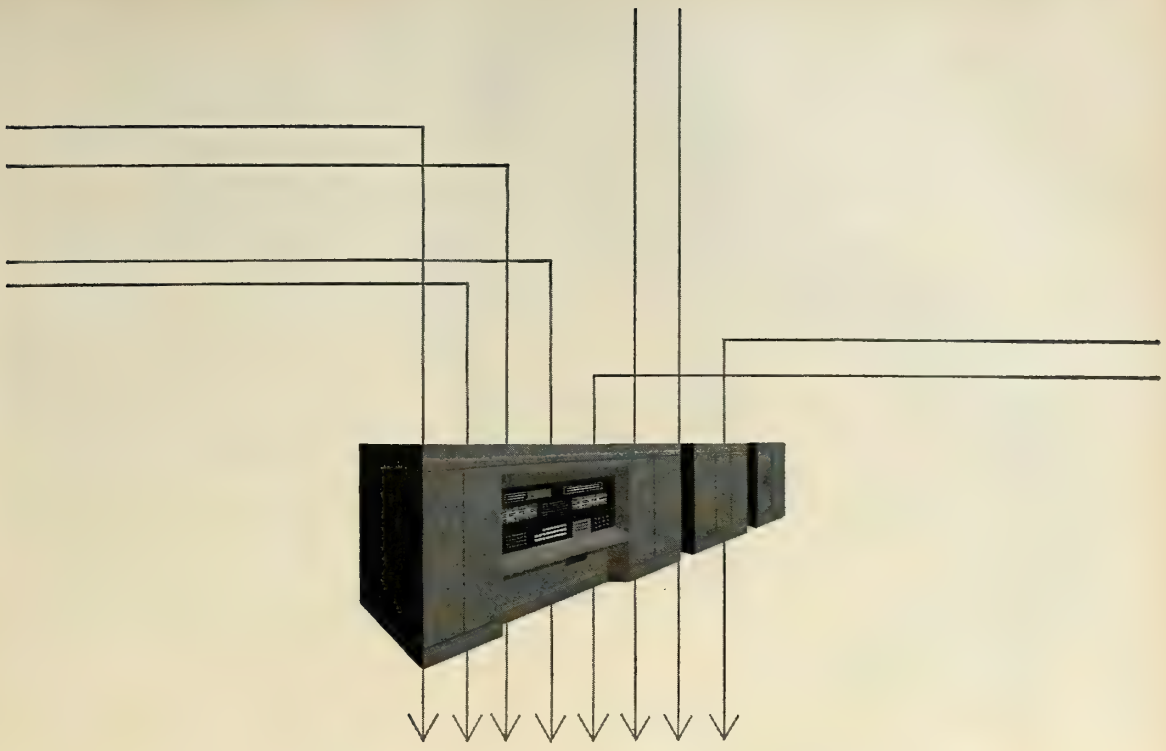
But, the small business percentage of the 1958 total was only 2.6%, as against 3.4% for the comparable period during the preceding fiscal year.

The February percentage was 4.4%, compared with 3.4% for the same month in the previous year. For fiscal year 1957, the awards to small business totalled 4.3%. Total awards to all firms during 1957 amounted to $3 billion.

In fiscal year 1959, which begins next month, the dollar for missile-space procurement will continue to spiral upward.

• **Report due**—The Subcommittee questioned whether the Defense Department's weapon system concept of procurement resulted in concentrating the bulk of the productive missile capacity in a handful of huge corporations. Hearings showed this is largely so, but the concept of procurement has grown so large, testimony indicated, that to change the system now could destroy the defense readiness of the nation.

Senators sought assurance that there are safeguards against permitting a few contracting officers, perhaps inadvertently, to go against the anti-monopoly work of the Department of Justice and the Federal Trade Commission. The



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. . . small business

committee wanted to know whether there's an increase in the trend of giant corporations to self-produce many items they never produced before, and also, how giant firms are using government-furnished facilities.

Senators inquired as to the government's security clause of "need to know", which may preclude many small business firms from gaining contract knowledge for competitive bidding.

The Senate group will probably make their report this month. Information received is that the subcommittee will praise the Navy on setting aside contracts for small business competition and giving small business a better share of the prime and subcontracting dollar.

The Army will get a reprimand for not farming out more small business contracts from its arsenal-concept of weapons development. The Air Force will be hit harder, because its ballistic missiles procurement precludes most small business participation in prime contracts.

The main theme of the subcommittee's conclusions will reportedly state that if the Defense Department continues to ask Congress to appropriate billions to usher in the space age, then every effort should be expended to utilize the talent and services now available in small firms.

• **Outlook**—Big business will continue to get the lion's share of the prime contract dollar, but reportedly, the Armed Services will be probing into contracts to insure that every possible consideration will be given to small business. The subcommittee is hopeful that small business soon will be averaging 25% or more of the missile dollar.

The report will also emphasize that, whenever possible, missile systems should be divided into components which can be furnished by competitive bidding. As missiles now under development reach hardware stage, the subcommittee will insist that more contracts be let by competitive bids. The report will also insist on increased information on subcontracting opportunity, possibly under revamped security conditions.

The following summary presents the cases of the three Armed Services before the Subcommittee.

• **Navy testimony**—Some 23% of missile money is believed to have gone to small business—3% in prime contracts and 20% in subcontracts. This compares with about 40% to small business for all Navy procurement.

BuAer gives missile contractors



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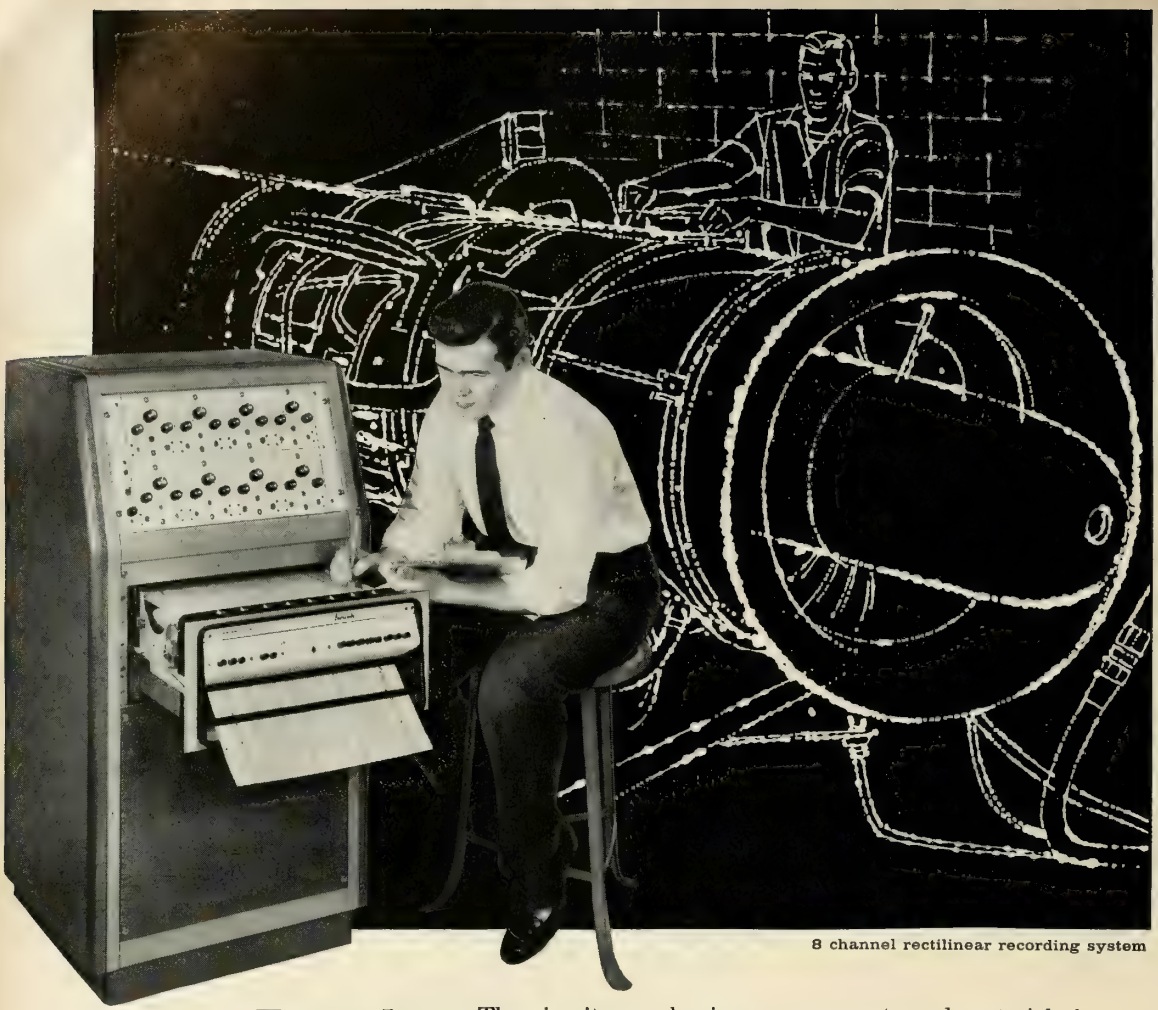
Input range	24.5 to 30.5 VDC	24.5 to 30.5 VDC
Nominal input	27.5 VDC	27.5 VDC
Output voltage	250 VDC	up to 500 VDC
Power output	50 watts	100 watts
Regulation	better than 8%	better than 8%
Ripple	1% or better, depending on requirements	1% or better, depending on requirements
Efficiency	up to 80%	up to 80%
Maximum mounting base temperature (operating)	+85°C.	+85°C.
Minimum operating temperature	−40°	−40°
Storage temperature	−65° to +100°C.	−65° to +100°C.
Weight	1 lb. 4 oz. (50-watt unit)	1 lb. 8 oz. (100-watt unit)
Size	4½″ x 2¼″ x 2⅛″ (minimum)	5″ x 3″ x 3″ (minimum)

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prime responsibility for *Sparrow* III, *Corvus, Bullpup* and *Regulus* I and II. Their reasoning is that primes have the capacity and can assume responsibility for producing a complete missile. Small business is precluded from this stage of procurement, but utilized in the next cycle—subcontracting.

On the *Sparrow*, the prime contractor (Ratheon Manufacturing Co.) has subcontracted, in the last three years, approximately 59% of dollars received from Navy. In 1956, small business got 48%; in 1957, 59%; and in 1958 (to date), 56%. This is largely due to the advanced stage of the missile, where standardization of many components makes bidding possible on a competitive basis.

Corvus started its career in 1956. In 1957, 2.6% of *Corvus* money went to small business; in 1958, 5.12%. Percentage probably will improve again next year.

Navy's BuOrd, which has cognizance over *Sidewinder, Talos, Terrier, Tartar,* and a special projects office for *Polaris,* points out that during fiscal years 1956, 1957 and the first half of 1958, six of its principal missile prime contractors did extensive subcontracting with small business. Here is the breakdown:

Prime Contractor	% Subcontracted	% of Subcontracted Dollar Awarded to Small Business
A	52	74
B	68	24
C	45	27
D	68.6	29.1
E	28	66
F	50	60

To date, some 2,500 to 3,000 small business firms have received subcontracts from *Polaris* prime contractors. Lockheed Aircraft Corp., prime system contractor for *Polaris,* has dealt with 901 vendors, 82% of them small business firms. And of the dollars spent, 73% were spent with small business.

Polaris primes have awarded approximately 80% of their subcontracts to small business. The following statistics illustrate this trend:

Contractor	Total Subs.	Small Bus.
Lockheed	901	739
Aerojet-General	158	131
Aerojet-General (as sub to IMSD)	155	116
Interstate Electronics Corp.	241	197

• **Army testimony**—Since the 1956 activation of Army's ABMA, small business has received 23.9% of Army missile dollars. ABMA spent $520 mil-



General-Purpose Test Vehicle

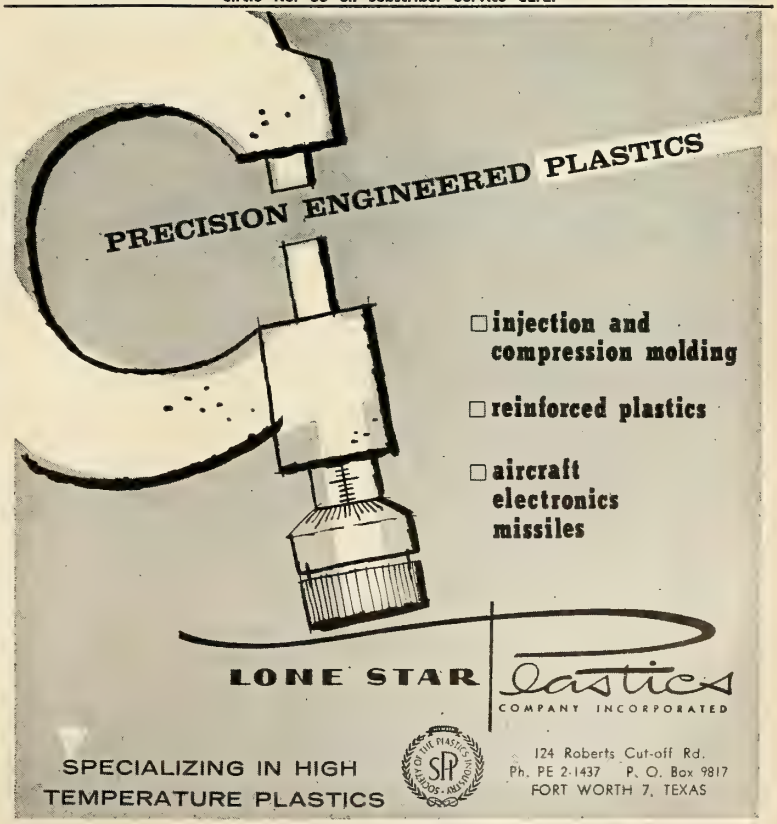
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. . . small business

lion on *Redstone, Jupiter* and *Jupiter* C in 1956, 1957 and up to March 1, 1058. Small business received $124 million of this amount.

Prime contractors passed on 19% of the dollars paid them to small business. Primes are Chrysler Corp., Ford Instrument Co., and North American Aviation. In the same period, Army made 1,574 procurements, many for applied research, with 51.3% going to small business.

Army reports that during fiscal year 1957 and the first half of 1958, prime contractors kept 28% of each dollar; 48% went to large business, and small business received 24% which amounts to about $152-million.

In 1959, Army expectations are: some 48% or $369 million will be subcontracted to large business; 28%, or $215 million will not be sub-contracted; and 24%, or $185 million will be subcontracted to small business.

• **Air Force testimony**—In the area of ballistic missiles alone, 21% (more than $267 million) of all money paid to prime contractors has gone to small concerns as first-tier subcontractors and suppliers. Some 58% of the funds for ground support equipment went to sources other than the system contractors, and of that, 44.8% went to small business.

Of five ballistic missile programs, Air Force says that small business has received approximately $117 million of some $603 million, or 19.4% of total dollars. There are 16 hardware producing primes in the ballistic missile program and approximately 250 principle subs.

Douglas Aircraft Co. is utilizing about 8,473 small business concerns as subcontractors of *Thor,* and more than 23%, or $18 million, went to small business.

The U.S. Air Force says as a December 31, total invoices to all prime contractors in the ballistic missiles program represented $1.3 billion. Of this amount, $269 million on first tier subcontract basis went directly to small business.

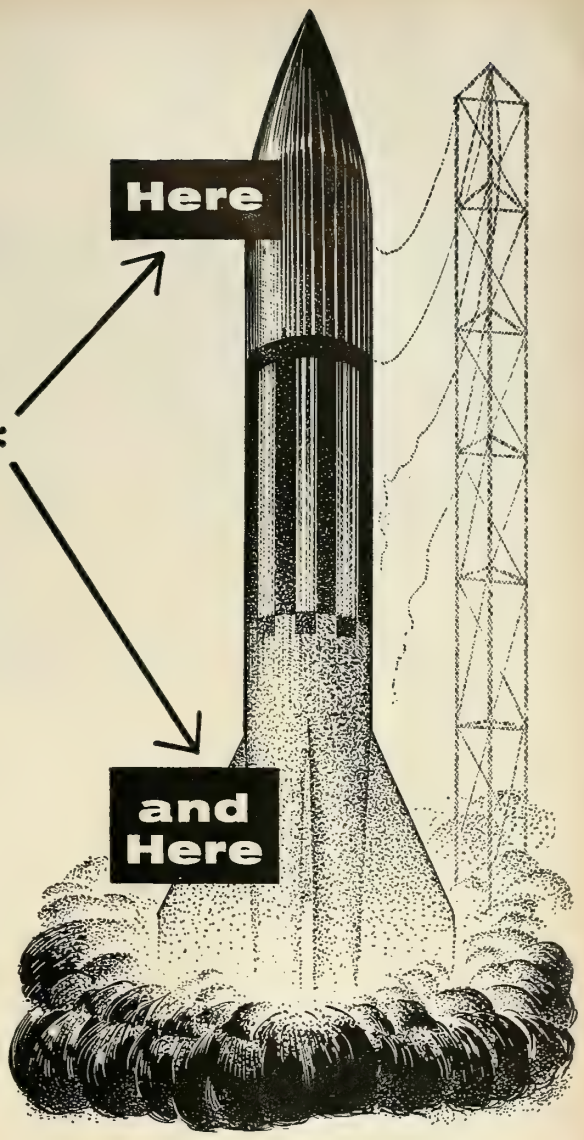
Convair Astronautics Division, prime contractor for *Atlas,* reports that more than 37%, or $105 million, went to 2,875 small business companies and their affiliates.

Martin Company, prime contractor on *Titan,* reports 27%, or $34.9 million, went to 1,500 small companies.

Rocketdyne, largest manufacturer of propulsion systems for *Atlas, Thor,* and *Jupiter,* reports 20%, or $45 million went to 4,000 small business organizations.★

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Maximum Collector Voltage (Emitter Open)	100	80	80	80	60	60	50	50	40	40 volts
Saturation Resistance (13 amp.)	.02	.02	.02	.02	.02	.02	.02	.02	.02	.02 ohms
Max. Square Wave Power Output at 400~P-P*	400	310	310	310	225	225	180	180	135	135 watts
Max. Sine Wave Power Output at 400~P-P*	180	140	140	140	100	100	80	80	60	60 watts
Power Dissipation (Stud Temperature 25°C)	70	70	70	70	70	55	55	55	55	55 watts
Thermal Gradient from Junction to Mounting Base	1.0°	1.0°	1.0°	1.0°	1.0°	1.2°	1.2°	1.2°	1.2°	1.2° °C/watt
Nominal Base Current I_B (V_{EC} = —2 volts, I_C = —1.2 amp.)	-19	-13	-19	-19	-13	-24	-13	-24	-13	-27 ma

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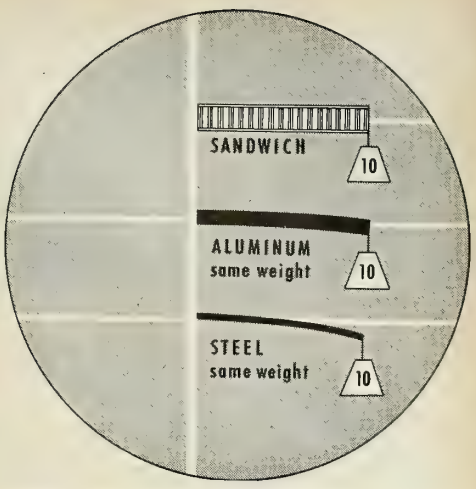
DELCO RADIO
Division of General Motors
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Antennas are getting bigger and . . . .

Sandwich Construction Keeps Them In Shape

by Herman Holland*



OUTSTANDING CHARACTERISTIC of Sandwich construction is high strength-to-weight ratio.

TWO PROGRAMS have created an urgent requirement for large tracking and scanning radar reflectors: the nation's accelerated program for developing long-range missiles; and the need for adequate missile defense systems.

In the field of long-range missiles, the steadily increasing range and altitude of the newer birds means that tracking antennas must grow in size. Experts familiar with the problem see a demand for reflectors ranging up to 100 ft. in diameter in the very near future.

In the field of missile defense, the longer ranges now demanded of radar already make very large size reflectors a necessity, and the longer ranges necessary in the future will create a need for even larger ones.

The electrical design of such reflectors is not an imposing problem, but the translation of any such design into usable hardware is another matter.

During actual operation, these enormous tracking and scanning reflectors must move constantly and with rapid acceleration to various positions involving elevation and azimuth.

Since the structures are essentially mirrors (or lenses), their parabolic reflective surfaces must be maintained with no appreciable degree of deflection if they are to be fully efficient.

Further complicating the problem is the fact that such reflectors must be capable of operating almost instantaneously under highly varied and frequently severe climatic conditions.

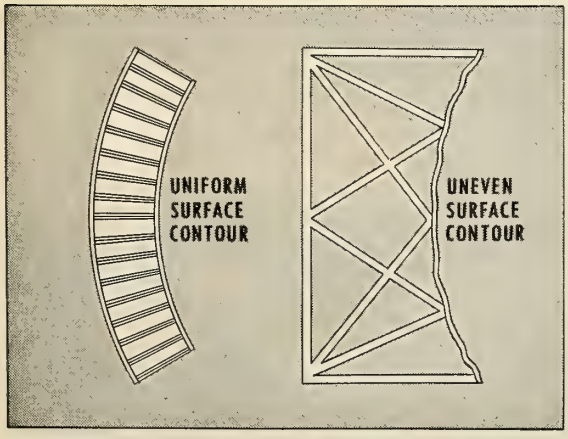
Such functional requirements pose real problems for the engineer accustomed to designing smaller reflectors. Although the performance requirements for smaller reflectors can usually be accommodated simply, these requirements become increasingly difficult to satisfy as reflector sizes increase.

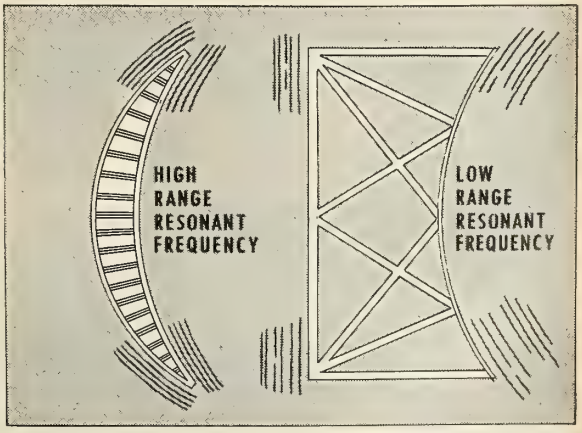
• **Enter the sandwich**—Under these circumstances, the design concepts and the materials selected for large reflectors become significant. Considering the combination of structural, environmental and functional conditions that influence the design of articulated reflectors, a first essential is that materials used offer a combination of highly rigidity and minimum weight.

Designers of missile structures, who have encountered similarly challenging rigidity-weight problems, have turned in many cases to sandwich structures for their solutions. It was natural, then, to turn to a similar construction method for large-size reflectors, incorporating, wherever possible, sandwich construction to hit the desired goal of optimum rigidity-weight.

At Narmco Manufacturing Co.,

Chief Engineer, Narmco Mfg. Co., La Mesa, Calif.

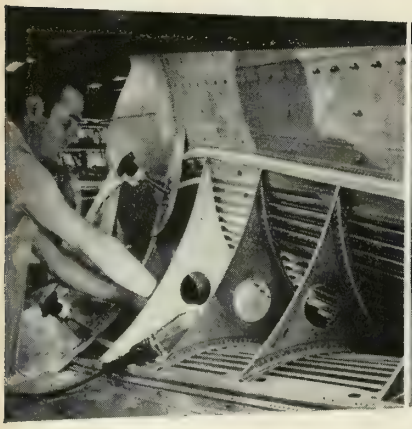


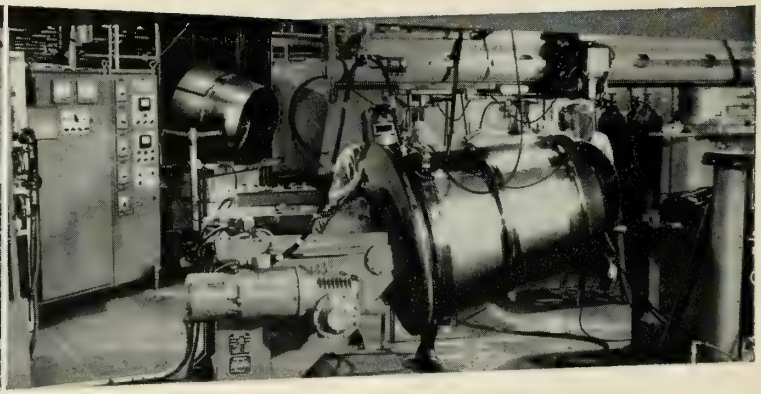


LEFT—Uniform surface contour maintained by sandwich construction. RIGHT—A comparison of resonant frequency. Frequency is influenced by stiffness, weight, and configuration; thus sandwich construction offers design advantages that are due to flexibility.

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. . . sandwich radar

engineers have found that sandwich construction offers a variety of design and performance advantages for large radar reflectors.

One advantage is contour fidelity of the parabolic reflective surfaces. Contour fidelity is chiefly influenced by the basic rigidity of the structure and rigidity, in turn, is influenced by two factors: the inherent stiffness of the structure and the weight of the structure.

Lightness is an obvious necessity in a reflector because deflection—whether created by acceleration and deceleration loading, by wind loading, or by loading caused by ice formation or similar environmental hazards—tends to increase sharply as the weight of a structure increases.

To some degree, weight actually establishes a vicious circle: the greater the weight, the more the loads tend to build up. Conversely, inherent lightness in a reflector offers cumulative performance advantages. Inertia load deflections caused by acceleration and deceleration, for example, are greatly reduced when the weight of the structure is minimized.

Weight and rigidity also influence the resonant frequency of a large parabolic structure. Generally, it is desirable to maintain the natural resonant frequency of a reflector in closely controlled ranges to avoid functional and mechanical problems involving the drive mechanism.

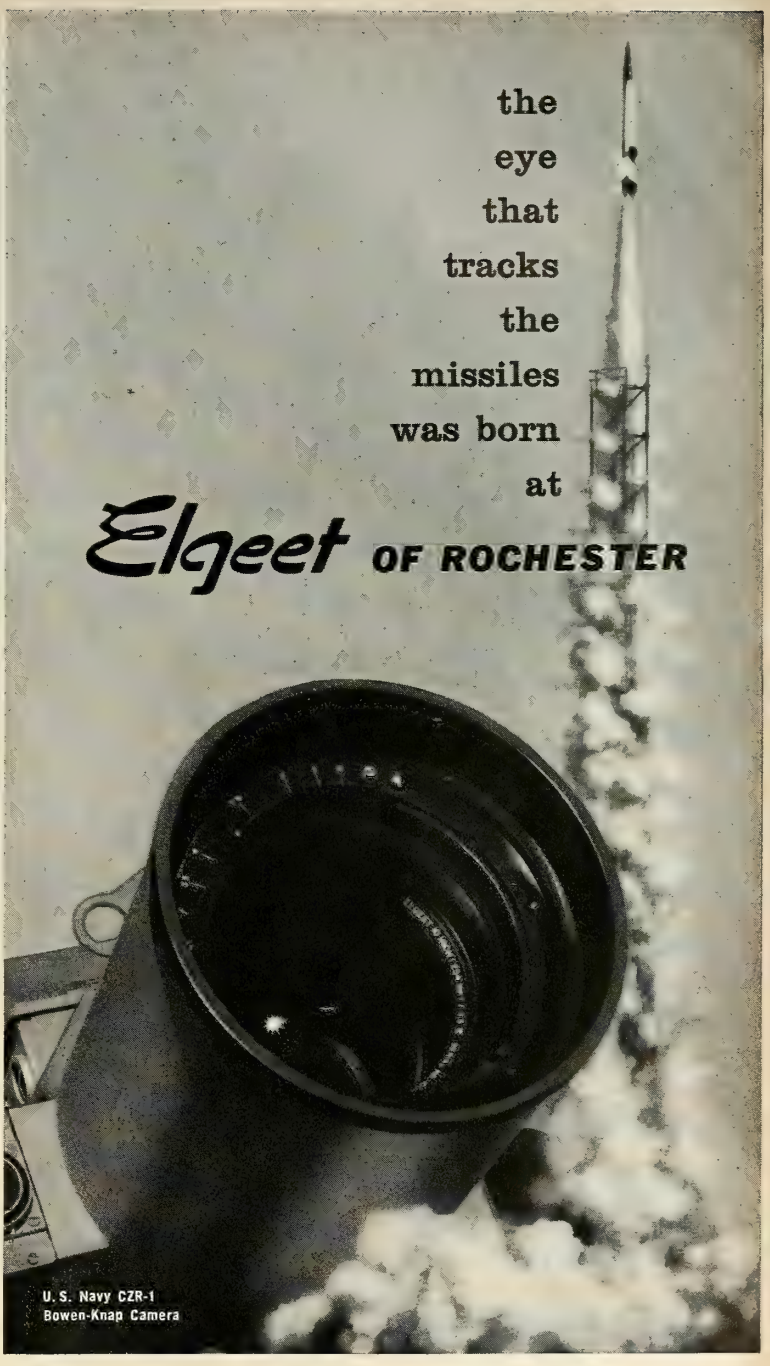
Basically, resonant frequency is influenced by both weight and rigidity along with configuration. In a sandwich structure these vital factors can be controlled through design, and the selection of face and core materials.

• **Construction details**—This makes it evident that lightness, plus inherent stiffness, are key design factors in a large reflector. Sandwich construction —as its capabilities have been widely demonstrated in the missile industry—offers the ideal combination.

Since a sandwich is essentially a composite structure in which the load-carrying elements are high-density face materials uniformly stabilized by a low-density core material, this type of structure offers exceptional section properties.

As a result of this full skin stabilization, a sandwich reflector maintains its design contour within extremely close tolerances. Also, inertia load deflections produced by acceleration and deceleration are reduced because of the inherent lightness of the structure.

Another important advantage is the inherent lightness which simplifies all



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SPECIFICATIONS: Lukens Nine Nickel is produced to meet ASTM A-353 and A-300 specifications. It is included in the ASME-UPV Pressure Vessel Code, Section VIII, 1956 edition.



PROPERTIES

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Minimum yield strength	60,000 psi.
Elongation in 2 inches, minimum, per cent	22.0

Charpy impact tested in accordance with ASTM A-300 Specification down to −320° F.



COMPOSITION

Carbon, maximum, per cent	0.13
Manganese, maximum, per cent	0.80
Nickel, per cent, (approx.)	9.00
Silicon, per cent, (approx.)	0.30
Phosphorous, maximum, per cent	0.035
Sulfur, maximum, per cent	0.040



for Low Temperature Service

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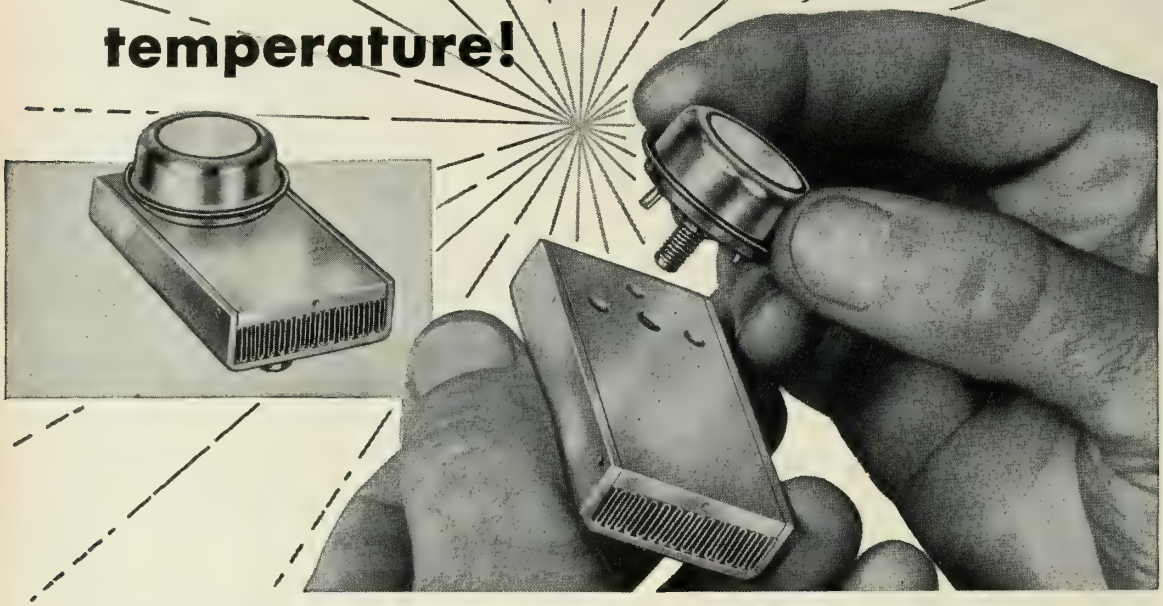
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Air flow: 7 lbs. per hr.
Air pressure drop: 0.25" H_2O corrected to .0765 density
Temperature drop in cold plate: 1.5°C per watt dissipated
Weight: Approximately 1 oz.
Performance characteristics can be modified to requirements.

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other elements of a reflector system—both from a functional and a cost viewpoint.

The size, complexity and power requirements of a radar reflector drive mechanism vary in direct proportion to the weight of the reflector itself. The more complicated the moving unit, the more costly and complex must be the driving mechanism. But by minimizing weight, the designer can also simplify the drive mechanism.

• **Size considerations**—Sandwich offers additional advantages as a design medium for large reflectors. For one thing, sandwich reflectors can be transported and assembled with comparative ease. In contrast to large reflectors of tubular truss design, which normally require expensive on-site construction, sandwich reflectors can be prefabricated in segments, and can be assembled at an isolated installation sites with a minimum of expense.

Because of its basic cellular structure, a sandwich reflector lends itself potentially to incorporation of an internal temperature control system. Such a system could serve to equalize the expansion and contraction of the sandwich faces when subjected to extreme temperature variations, that would otherwise render the reflector inoperative, perhaps when most needed.

While sandwich offers a number of design and performance advantages, it should not be regarded as the solution to all large reflector design problems. In the case of reflectors of extremely large size, it is possible that a combination structure may prove to be the optimum design. In such massive structures, many design problems must be taken into account.

Although reflectors up to 30 ft. in diameter can probably be fabricated entirely of sandwich materials, they require a combination of sandwich construction plus external bracing.

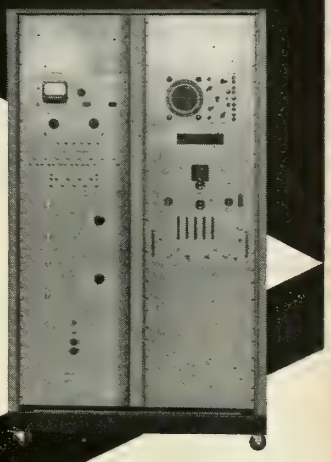
Another consideration is that, as the range and altitude of missiles increase, the "eyes" of radar systems must probe ever further and with ever greater signal fidelity. These requirements may not only obsolete the familiar open-grid reflector, but make a continuous-surface reflector a mandatory design.

In a conventional open-grid structure, a continuous reflective surface must, in essence, be superimposed over a tubular truss skeleton, thereby adding materially to the weight of the total structure. However, the continuous reflective surface is actually an integral load-carrying component of a sandwich structure and serves a dual role at no increase in overall weight.★

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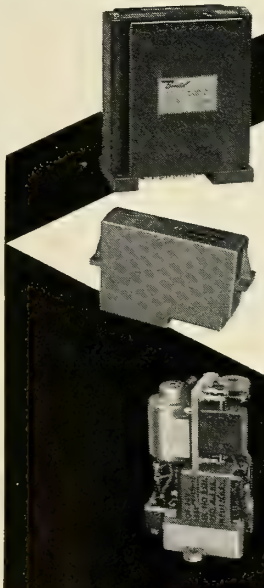
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Low temperature capability, extended life, accuracy under extremes of shock and vibration and low power drain are features of these frequency modulated units.

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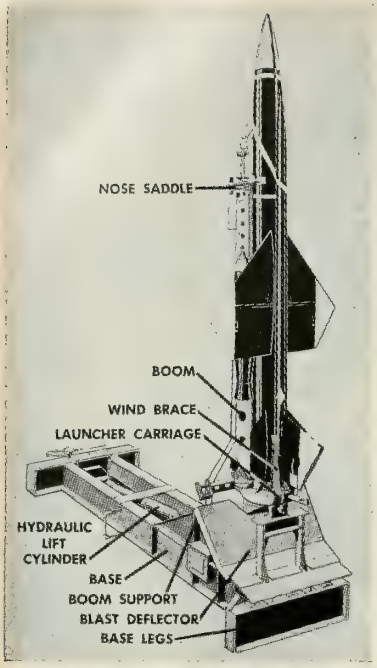
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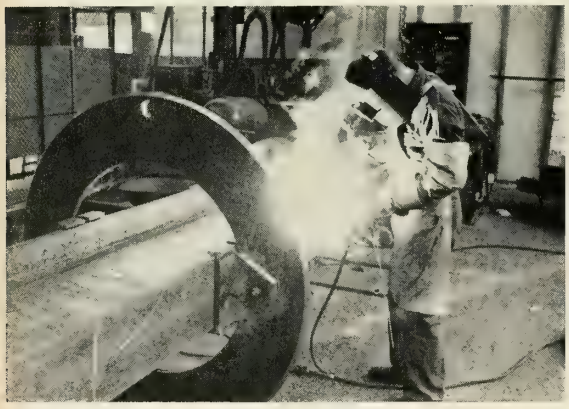
Ground Support Manufacture:

Launchers Challenge Structural Engineers

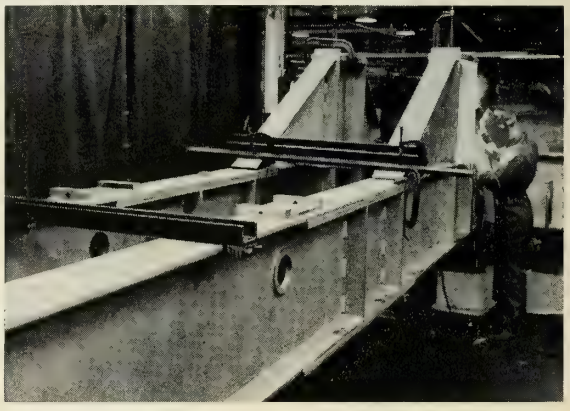
Launchers and erectors, with their related hydraulic and electric support equipment, are the largest single subsystem in the missile weapons system. They may range from simple racks or pads and truck mounted rails to elaborate, complex launcher-erectors.

In the *Bomarc* system, each missile will be housed in an individual hangar, mounted on its launcher erector in a horizontal attitude, fueled, checked out and readied to fire. Within seconds of a firing alert, the hangar must open, the missile be erected and the erecting boom moved away from the missile. To lift the 8-ton *Bomarc* smoothly and swiftly, and hold it in position against surface winds, dictated the development of a heavy 13-ton highly efficient launching system.

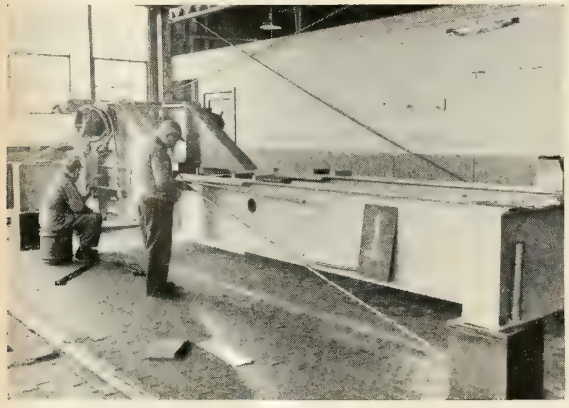
Several of these launchers, slated for installation at the *Bomarc* operational training base at Eglin AFB, Fla., are being produced for Boeing by the American Machine and Foundry Company's Buffalo, N.Y. plant. These pictures illustrate a part of the AMF operation.



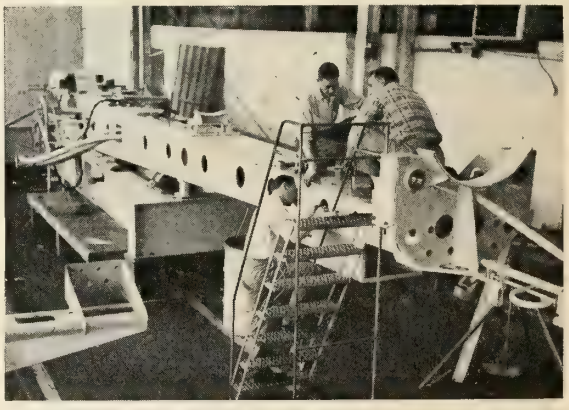
1 Beams supplied by U.S. Steel are cut to length and webs reinforced in first operation of launcher base fabrication.



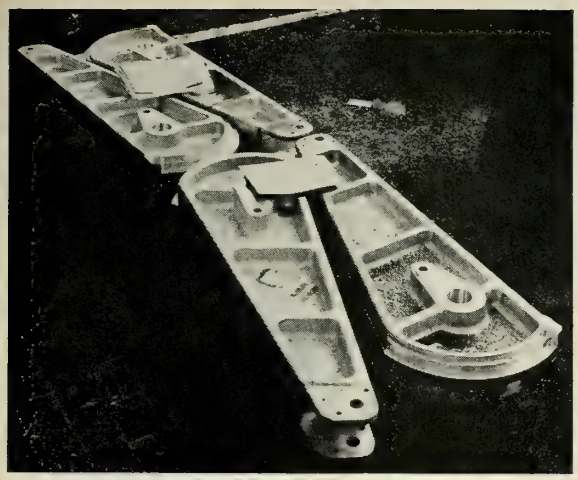
2 Boom supports and base legs are welded to finished base section in jig designed to hold tolerances to within ± ⅛ in.



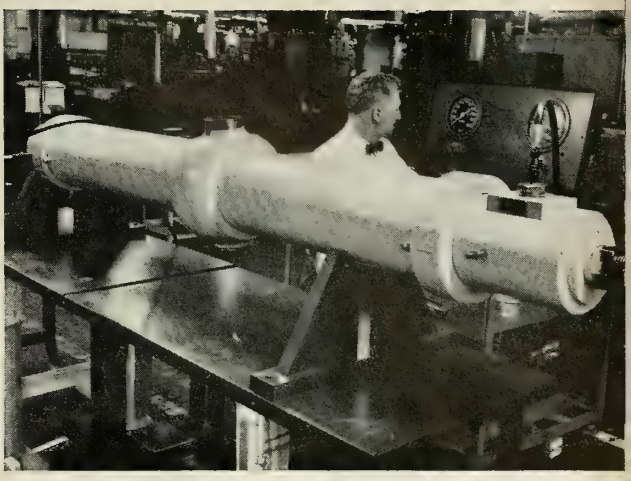
3 Completed base—sand blasted, and painted—is moved to final assembly where lines and wiring are installed.



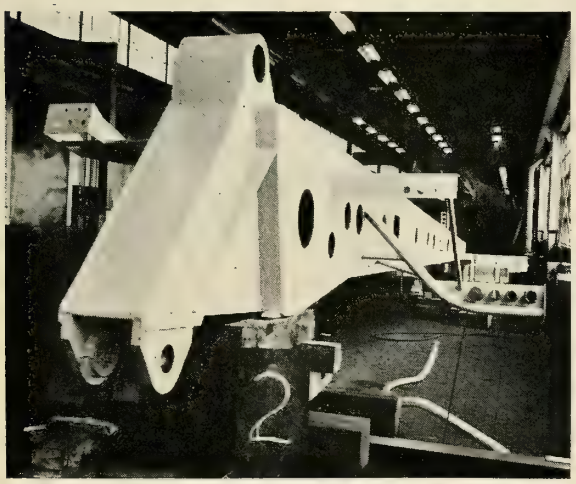
4 Launcher in final fabrication. Boom and lift cylinder are in position. Last conduits are being installed near nose saddle.



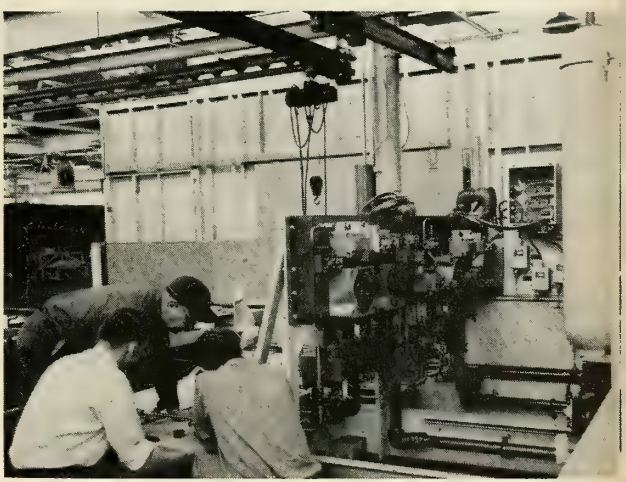
5 Forged missile wind braces are machined to close tolerances at AMF Buffalo.



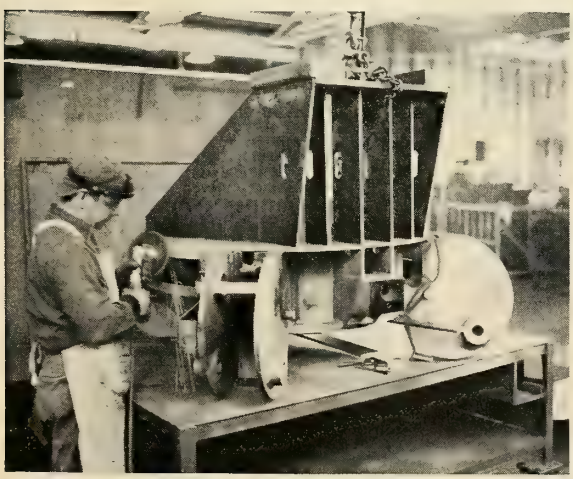
6 Hydraulic cylinder for operation of boom is pressure tested after arrival from Elko Products.



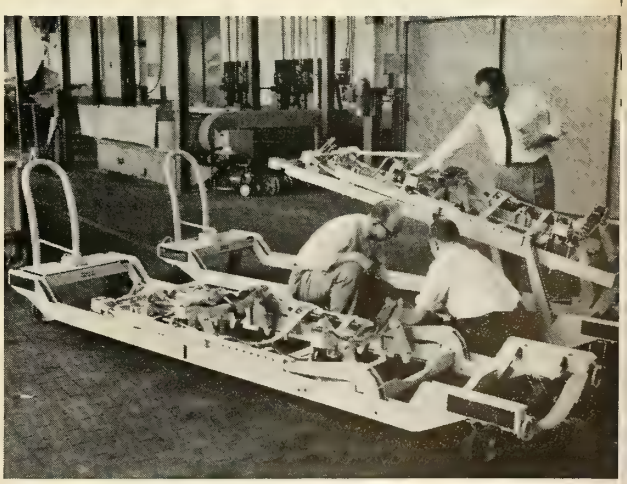
7 Missile boom, stored in final assembly area, as received from Lukens Weld and Wayne Pump.



8 Final adjustments are made to the *Bomarc* hydraulic power supply. Unit will be installed in missile hangar.



9 Launcher carriage, in an inverted position, during grinding operation for removing rough weld heads.



10 Ramjet loading and fueling dollies are inspected by Boeing and AMF engineers.

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Automation

Computer Effects and Social Effects

SPACE TRAVEL will depend directly upon the use of computers—both in design and in their present use as controllers.

These were the thoughts expressed by C. C. Hurd, director of automation research, International Business Machines Corp., in a speech at the annual Western Joint Computer Conference in Los Angeles, Calif.

Hurd asserted that the most important effect of automation is its influence on man and his thinking. It is now possible to contemplate certain "adventures" which would be impossible without automatic methods of information handling.

• **Computer applications**—The bulk of the conference was dedicated to computers per se rather than to specific applications, tlhough there were several applications of the machines to the missile and aircraft fields.

Prominent among the displays was the Athena computer system, designed as part of the ground-based guidance system for the Air Force/Martin-Denver *Titan* ICBM, and built by the Remington-Rand Univac Division, Sperry-Rand Corp.

The Athena has the task of following the missile's flight with radar—determining position, direction, and velocity. It then compares this input information with that of the desired flight path. The comparisons will be made at one-half second intervals.

Any corrective action required will be automatically transmitted to the missile's airborne guidance section.

• **Social effects**—Speaking on "The Social Problems of Automation," Prof. Harold D. Lasswell, School of Law, Yale University, warned that automation "speeds up the tempo of whatever it touches."

"The most complex weapons and weapons centers are supervised and tended by rather small teams. Infiltration and surprise depend upon small, agile units; and sabotage and espionage networks call for such structures. With the spread of automation, components of the total machine become vulnerable to the well-placed few.

"Automation has an important psychological effect by reducing emotionality in combat preparations or activities. The machine intervenes between fighters; the target is an incident in complex and impersonal sequences," the Professor declared.★



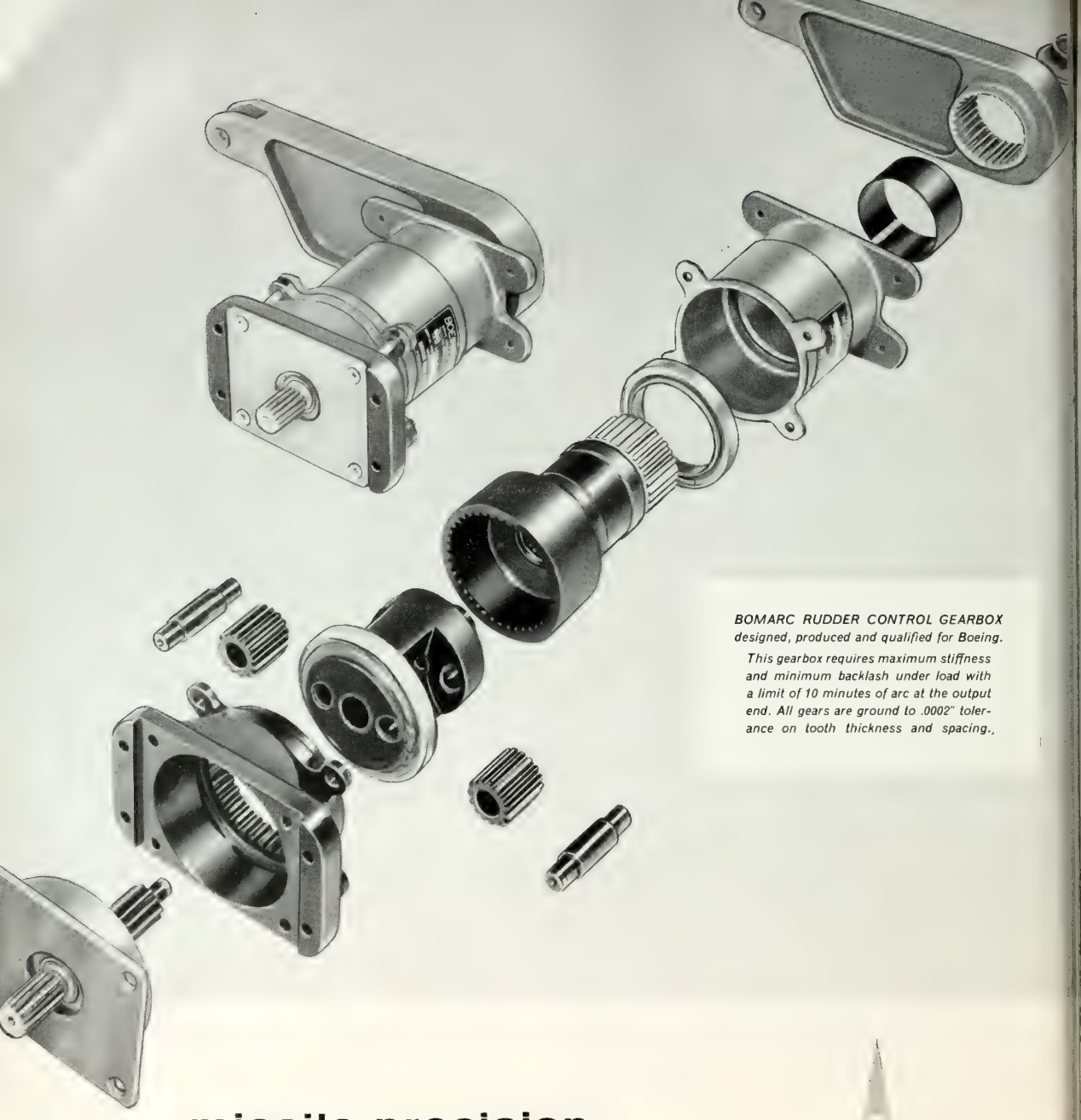
Measuring the bore of a steel liner ground in assembly with the lower housing of the Sikorsky S-56 Helicopter transmission. Its complex, thin-walled casting must be machined with all bores and faces within an angular tolerance of plus nothing and minus one minute and thirty seconds and with linear tolerances of plus or minus .002.

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Dr. Fred L. Whipple—

Eyes on the Skies



by Erica Cromley

THE NEWLY AWAKENED interest in space is pushing the nation's top astronautical scientists out of their laboratories and onto the platform to feed a hungry public the facts.

Added inroads are made on scientists' valuable time by the various governmental agencies and bureaus, which suddenly find that the satellite era has thrust part of their operations into the space picture. One of the men most in demand is the director of the Smithsonian Astrophysical Observatory, Dr. Fred L. Whipple, who heads the U.S. satellite optical tracking program, which includes Operation Moonwatch.

Although he realizes the importance of scientific liaison with the government and the public, Dr. Whipple foresees a possible danger: "Older scientists must now serve on so many committees that they don't have time to teach younger scientists. This means that in a few years we may not have any scientists, only committees."

• **Pre-Satellite efforts**—Dr. Whipple's first active contribution, directly related to space flight, dates back to 1946 when he was a consultant for a secret Rand project and wrote the paper, "Possible Hazards to Satellite Vehicles from Meteorites."

During the late '40s and early '50s, Whipple and a few other forward-looking scientists "tried to stir up interest" in space flight in government circles, although this was not a coordinated effort.

By 1954, the space-wary government was beginning to thaw. In November of that year, Fred Whipple participated in the original meeting on Project Orbiter, at the call of Naval Commander George Hoover.

Other space enthusiasts present were Dr. Wernher von Braun, Dr. Fred Singer, Austin W. Stanton of Vargo, Inc., and Fred Durant, the first president of the International Astronautical Federation.

Things moved quicker after that. In the summer of 1955, while the Whipples were Europebound, the President announced that the United States would put up a satellite as part of its participation in IGY.

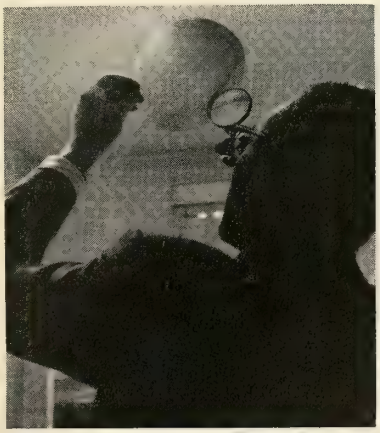
Fred Durant recalls that shortly afterward, when he met Whipple in Copenhagen where the IAF was meeting, they toasted President Eisenhower's historic announcement, under the impression that Project Orbiter was at last underway.

• **Moon tracking**—Just before the European trip, Dr. Whipple had left his post as chairman of Harvard's Department of Astronomy to head the Smithsonian Astrophysical Observatory at Cambridge, Mass. After the decision to launch *Vanguard,* there was no question as to the National Science Foundation's logical choice to head the visual tracking teams.

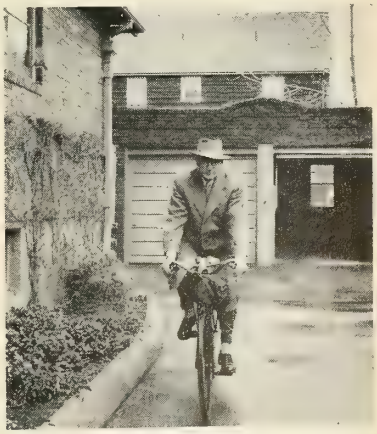
When Dr. Whipple first took over,



DR. WHIPPLE paints abstractions using math formulas as color and line guide.

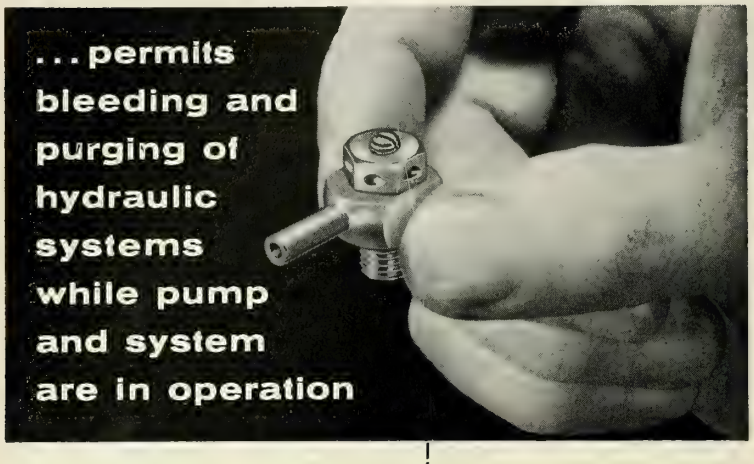


THE MAN who heads our satellite visual tracking program probes *Sputnik* photo.



THE ASTRONOMER pedals to work from his home in Belmont, Mass.

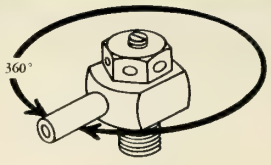
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the observatory's staff numbered six. Under the impetus of the coming satellite program, the staff grew to almost 100. One scientist said recently that "Whipple has a natural talent for administration. Morale at the Observatory and throughout the Moonwatch program has been extremely high. His arrival really gave a shot in the arm to the Smithsonian."

The twelve official world wide tracking stations, and the 230 volunteer observer posts, are on an around-the-clock watch to follow the man-made moons through their orbits. Findings are then sent to the Observatory at Cambridge.

Dr. Whipple, J. Allen Hynek, associate director of the Smithsonian, and the staff coordinate and feed the information into computers and analyze the findings. Eleven formal reports have been produced, and the first comprehensive published report is expected next month in the Smithsonian publication, "Contributions to Astrophysics."

Whipple's present post marks the second time that the government has called on the famed astronomer for assistance in an official capacity—although he has served on many panels, and acted in an advisory capacity.

• **Operation Window**—The United States first tapped Whipple in 1942 to head Operation Window, the radar countermeasure used successfully by the Army and Naval Air Forces.

It is a confusion reflector consisting of small packages of one-half wave length aluminum dipoles, which when released from a plane, scatter and act as tiny antennas, sending back decoy echoes on the enemy's radar screen.

Whipple said that Operation Window "was considered so hot nobody wanted to do anything about it, because we were afraid the Germans might pick it up and do even more with it. We finally went ahead anyway. We found out after the war that the Germans had also thought of the idea early in the war, but hesitated to use it for the same reason."

Whipple's wife, Babette, said that Operation Window marked the turning point in her husband's career . . . "It brought him out of his ivory tower."

• **Early trends**—Whipple received his AB from the University of California in 1927, and admitted that he "was not too clear" where he was going. "I didn't exert myself too much in college. I took courses that were easiest, like math."

"It was at graduate school," his

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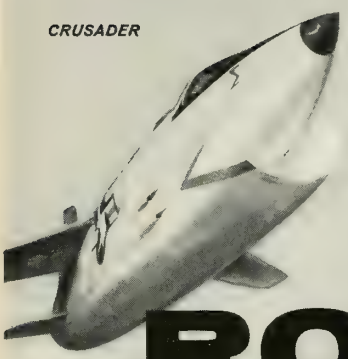
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wife added "that he decided to become an astronomer and started to really study."

Whipple was an avid tinkerer from the time he was quite young. Projects that he worked on in the toolshed on the Red Oak, Iowa farm, included building models with a Meccano Set and experimenting with chemicals. "Then I went into my photographic phase," Whipple recalls. When he was in his teens, he built radio receivers, "though I never became a ham."

Dr. Whipple credits his parents with spurring his interest in science "mainly because they were consistent in their discipline. A consistent upbringing is necessary for the young mind with a scientific bent. It gives you the feeling the world is in an orderly system and a sense of order is of prime importance to a scientist." The elder Whipples also encouraged him in his attempts to satisfy his insatiable curiosity.

• **The Drs. Whipple**—Mrs. Whipple is the present source of encouragement to her husband through the long hours and tremendous pressure brought on by the satellite programs.

She is also a scientist in her own right, though her interests are in the social rather than the physical sciences. She has a PhD in psychology from Radcliff, and now works in psychological research on children at Massachusetts General Hospital.

Although Whipple is away from home much of the time, Mrs. Whipple accompanies him on some trips. "I don't like him to be away," she admitted, "but on the other hand, trips give him freedom from the everyday 'incoming' basket and the tremendous responsibilities and constant decisions at the office. Sometimes trips afford the only opportunity for him to do some uninterrupted serious thinking."

The Whipple's two little girls are fast becoming astronomy-minded. Sandra, eight, and Laura, six, are spending a lot of time star-gazing, but their mother feels this is due to the little boy next door "who is mad on astronomy," rather than their father.

All four Whipples are bicyclists. Dr. Whipple cycles to and from work "as long as there is no precipitation and as long as the temperature is greater than 10° above zero."

Another activity in which Dr. Whipple indulges is rose gardening, although he breeds roses more for scent than for looks. The 51-year-old scientist pitches in with the housework occasionally "to keep fit." His wife doesn't encourage this, because she "doesn't approve of husbands taking over around the house."

A strictly enforced Whipple rule is "no plans are ever made for Sunday." Mrs. Whipple said that "since my husband's time is so regimented, he wants one day when he can do what he feels like doing—so no invitations are extended or accepted for Sundays."

Both Mr. and Mrs. Whipple dabble in painting. He concentrates on abstracts "because I can't draw too well." Recently, he began experimenting with Stochastic painting—abstractionism carried to its ultimate, in which mathematical formulas determine the length and direction of the lines and the selection of colors. He calls it "a cynical approach to art" but says the results have been "interesting."

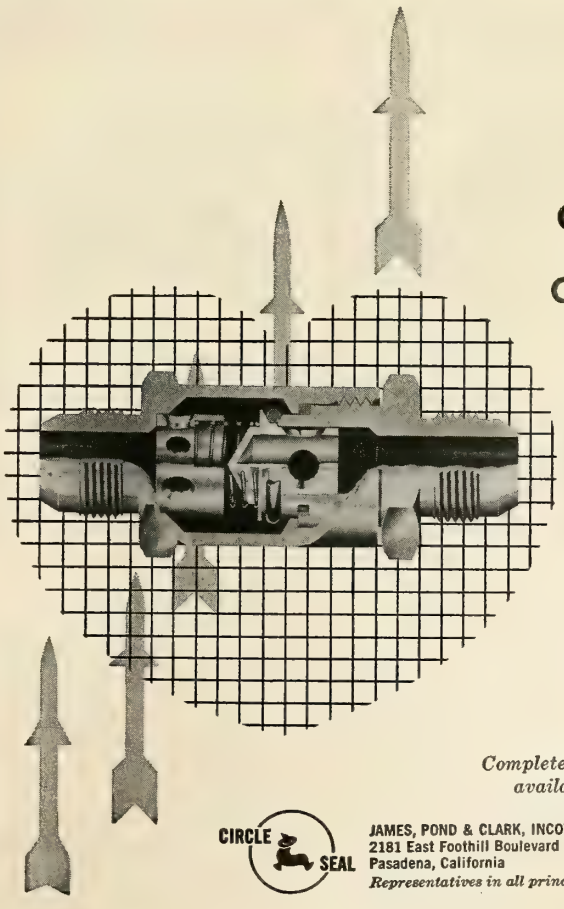
• **Scientist's scientist**—Dr. Whipple is highly regarded in the scientific community, where he is known as "a scientist's scientist." He has written over 130 articles on astronomy, including a contribution to a controversial series of articles which ran in COLLIER'S magazine, and later became the book: ACROSS THE SPACE FRONTIER.

Whipple has strong opinions on many subjects. "He doesn't hesitate to disagree with people" said Fred Durant, who attended a recent astronautical symposium with Whipple.

At the symposium, Dr. Thomas Gold had stated that dust thickness on the surface of the moon averaged about 100 ft. Whipple disagreed and made the statement, widely quoted in the press, that there was "no more dust on the moon than on the top of your piano."

This, of course, was a head-on run-in with prevailing scientific opinion. Another of Whipple's strong opinions was expressed at a recent House Space Committee meeting, at which he emphasized that the new space bureau should be independent of the military.

• **Red Carbon**—One measure of the success of Whipple's satellite tracking program was revealed during his appearance before the Space committee: the Russian scientist have used our Moonwatch program as the basis for their own visual satellite tracking programs.★



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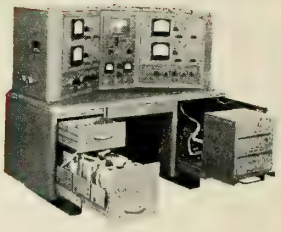
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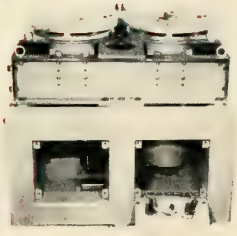
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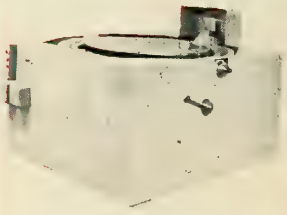
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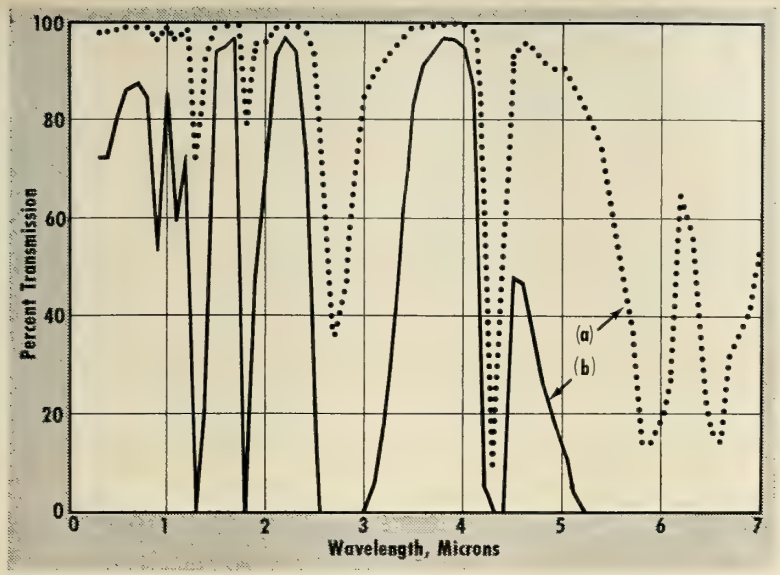


FIG. 1. Transmission of the atmosphere at (a) ten mile range at 50,000 ft. (b) one mile range at sea level. Transmission increases at higher altitudes.

Infra-Red: New Uses for an Old Technique

by Roger S. Estey*

THE GENERAL PRINCIPLES of the use of infrared radiation for detection and guidance with respect to distant objects are well known. Equipment has been built and is operational which will detect and track objects on land and sea or in the air.

The technical press has carried many excellent survey articles and detailed reports of developments in this field. The application of these techniques to missiles and space vehicles specifically, however, poses unusual problems and creates a wealth of new technical possibilities which will be discussed in this article.

The infrared portion of the spectrum is used for military applications not only because many targets emit in this region, but also because the avoidance of visual radiation produces a certain degree of operational security. This latter feature is of limited value in some of the newer applications. When appropriate to the discussion which follows, any or all regions of the optical spectrum will be considered.

Basically, infrared techniques can be used to perform one or more of four fundamental functions, namely: a) detection, b) recognition, c) tracking, d) communication. It will be shown that three of these functions are typically passive, and the other is inherently active in nature.

Infrared is usually considered a passive technique, that is, the equipment responds to the characteristic thermal radiation from the target. When used in this mode we are able to detect, recognize, or track objects which radiate thermally because of combustion of fuel, aerodynamic heating, or insolation (exposure to sunshine).

The principal use of active infrared is in the communication field, where the line-of-sight characteristics of the infrared beam lead to a high degree of security and small power requirements.

• **Atmosphere and background**—The absorption by the atmosphere seriously limits the performance of infrared devices which operate in close proximity to the earth. This absorption is most serious when the path between source and detector is long, and when the path traverses regions of low altitude.

The range of atmospheric transmission values to be expected is shown in Figs. 1 and 2. The upper curve of Fig. 1 shows the transmission over a ten-mile horizontal path at 50,000 ft. Although there are a few sharp and narrow absorption bands, the atmosphere is essentially transparent under these conditions from the near ultraviolet to the practical long wavelength limit of photoconductive cells. At higher altitudes the transmission is greater.

The lower curve in Fig. 1 illustrates the transmission of a one-mile path at sea level. It is also reasonably representative of the transmission of a vertical path through the total atmosphere. It will be noticed that in this case the infrared signal is confined to specific "windows" in the atmosphere.

The tangential path from a point on the earth's surface is an absorption path of particular interest in space navigation. A space vehicle located a few hundred miles or more from the earth's surface will be unable to resolve small terrestial details, but will be able to establish a line of position with respect to the earth as a sharp-edged disk.

The discontinuity between the earth and its atmosphere, each of which is radiating thermally, and the adjoining cold outer space, produces an abrupt signal gradient.

Two items are of interest here. The properties of this tangential path are quite independent of the range to the space vehicle or missile. Hence, the transmissive properties can be adequately and readily determined by solar

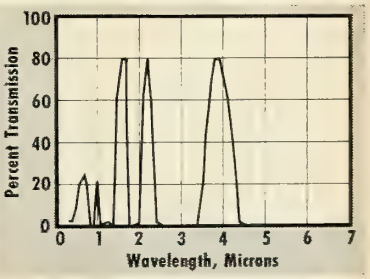


FIG. 2. Transmission of a tangential air path.

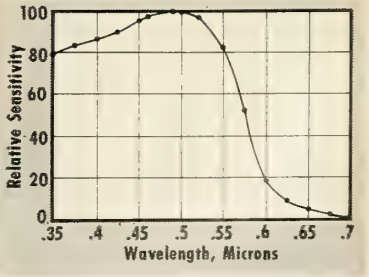


FIG. 3. Spectral sensitivity of multiplier phototube.

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Maurice Tucker, Aero-Thermodynamics Department Manager, right, discusses combined aero-thermodynamic re-entry body tests being conducted in Division's new "hot-shot" wind tunnel. Others are Dr. Jerome L. Fox, Assistant Department Manager, Thermodynamics, left, and Robert L. Nelson, Assistant Department Manager, Aerodynamics.

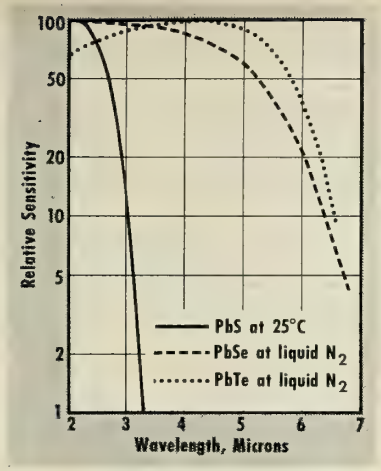


FIG. 4. Sensitivity of photoconductors.

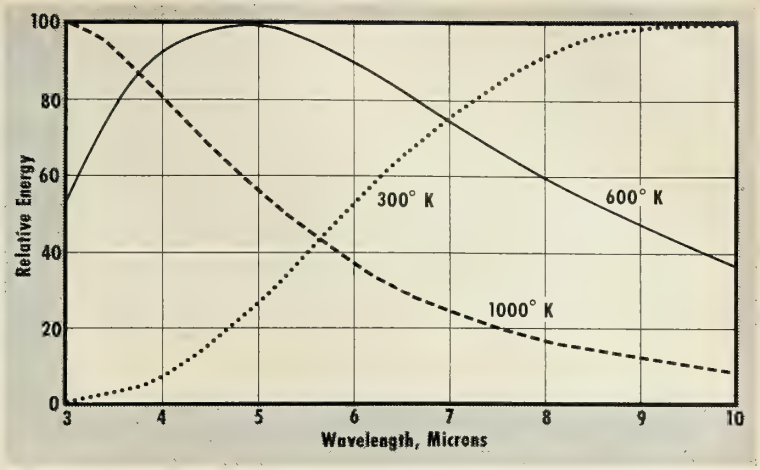


FIG. 5. Blackbody curves normalized at maximums, wavelength vs. relative energy.

observations at zero altitude (sunrise or sunset).

There appears to be no available means for measuring the signal discontinuity from a terrestrial surface point. A very high altitude laboratory would be required.

From the viewpoint of infrared techniques above the atmosphere—how are we to describe the background radiation for space? The sky background of outer space is startlingly black, against which the stars, planets, and the sun stand out in tremendous contrast.

Three other features are conspicuous. The background radiation of star light corresponds to a very high blackbody temperature, so that the peak of the spectral distribution curve is in the visible. This is totally different from the low temperature radiation from heated vehicle or missile surfaces, or from the band-type emissions from rocket flames.

The sky background of stars has a fixed distribution of energy in space. This means the sky background can be mapped and charted, and may serve for the rough determination of position.

This technique can be employed with instruments of very limited angular resolution, which may be advantageous in some cases. The energy distribution of the sky background can be mapped from the earth and programmed into an instrument for use as required.

Within the atmosphere, observers have been plagued by scattering of solar energy. As a result, the infrared background by day is several magnitudes more intense than by night. This distinction is so serious that different techniques and different standards of performance are obtained in the two cases.

In space, day and night do not have the same significance. The sun's angular position in the field, or the fortuitous obstruction of the solar rays by the earth or moon, are the important elements in a given situation. Space vehicle velocities are fast enough to seriously limit the usefulness of any such periods of obscuration that may occur.

Radiation from the atmosphere has irregular gradients in space and irregular variations of intensity with time, so that a background signal of optical noise is superimposed on and degrades any signal carrying intelligence. So far as we know, space backgrounds do not have these characteristics and the background of any modulated signal will be extremely quiet.

• **Sources of infrared radiation**—Infrared sources under discussion include missiles, space vehicles, celestial objects, and the earth's surface. Types of radiation include blackbody radiation which is distributed more or less uniformly over the spectrum, and the radiation from flames.

Flame radiation is emitted largely at those wavelengths corresponding to the atmospheric absorption bands. As a result, the increase in signal from flames due to high altitudes is very much greater than the increase of signal from blackbody-type of radiation.

Missiles during take-off and boost emit copiously from the tail flames. This radiation is very intense and conspicuous. After boost, the missile emits a conspicuous signal whenever the surface temperature is high from the combustion of fuel or from aerodynamic heating.

As a result, the signal from missiles may well persist over-all but a short interval in the middle of the flight.

Space vehicles are heated by solar radiation and in turn radiate to space. The heat balance between these phenomena determines the resulting vehicle temperature. A hypothetical example, grossly over simplified, will serve to illustrate this.

Assume our space vehicle is a sphere with a skin which is a perfect conductor of heat and has an emissivity equal to unity. Since the solar constant is 129.6 watts/ft^2 at the mean distance of the Earth, and since the insolation is proportional to the projected area, the radiation incident on the sphere is 129.6 watts/ft^2 of projected area.

This absorbed radiation will raise the surface temperature, uniformly it is assumed, until the radiation emitted from the total spherical surface area just balances the radiation received on the projected areas. For a sphere, these areas are in the ratio 4:1 and so the heated sphere will radiate 32.4 watts/ft^2.

This corresponds to a skin temperature of 280°K. This skin temperature can be increased slightly (approximately 40°) by the use of a reflecting surface on the side away from the sun. Similar techniques can decrease the skin temperature of the space vehicle considerably.

This means that space vehicles are not effective infrared sources in terms of their thermal emission, and this small signal can be decreased if desired, but cannot be increased significantly.

Celestial objects, the sun, planets, and stars emit in various parts of the spectrum without restriction. Since position is the only information to be obtained from the observation of these

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objects, the techniques are dictated entirely by the special character of the sources and the sensitivity characteristics of available detectors.

These are all very high temperature sources with maximum energy in the visible region of the spectrum. The experience of astronomers, on the one hand, and engineers working with daytime star trackers on the other, indicates that techniques involving the visible and the very near infrared regions are most satisfactory for the observation of celestial objects.

The earth's surface can be observed from missiles or space vehicles. The information may be used for guidance, involving the vehicle's position, or for reconnaissance, involving the study of terrestrial features. Surface features have low thermal contrast and are difficult to pick up.

Nortronics and other organizations are working on sophisticated infrared instruments involving special scanning routines, multiple channels, contrast control by optical filtering, and other techniques.

Guidance with respect to conspicuous local surface features poses a difficult problem in discrimination and interpretation, and may require the support of reconnaissance by infrared mapping.

Guidance of space vehicles at too great a distance for the resolution of surface features is another matter. In this case, the earth is seen as a disk with a conspicuous edge, and the signal contrast between the thermal radiation from the earth at approximately 300°K and the negligible radiation from the adjacent segment of space is very large.

This steep gradient can be observed instrumentally, and the center of the cone swept out by the observing instrument is the true vertical from the geometrical center of the earth. The accuracy of such a measurement is limited by atmospheric refraction and by the non-spherical nature of the earth's surface, with or without cloud cover.

Refraction is a substantially constant correction of about 0°–35′. The effect of mountains, clouds, and the ellipticity of the earth can be lumped together. They are associated with specific regions of the earth, and produce effects which are definite in linear measure, but produce angular errors inversely proportional to the range.

The transmission of the tangential air path shown in Fig. 2 shows a deep and wide absorption band between 2.5 and 3.4 microns, and a very transparent window between 3.4 and 4.4 microns. If measurements are made in the four micron window, the gradient will be more abrupt and will represent the tangent to the earth's surface.

Measurements made in the three micron absorption band will show a less abrupt gradient which measures the outer portion of the atmosphere. The effective depth of the atmosphere varies with latitude and with the distribution of the continental masses.

It is believed that these variations are significantly larger than surface variations, and it is also believed that horizon detectors should use the four-micron window.

• **Detecting instruments**—It is clear from the previous discussion that two distinct types of instrumentation are required, corresponding to sources of low and high temperature energy distributions. Generally speaking, instruments with peak sensitivity in or near the visible range are most suitable for the observation of self-luminous celestial objects.

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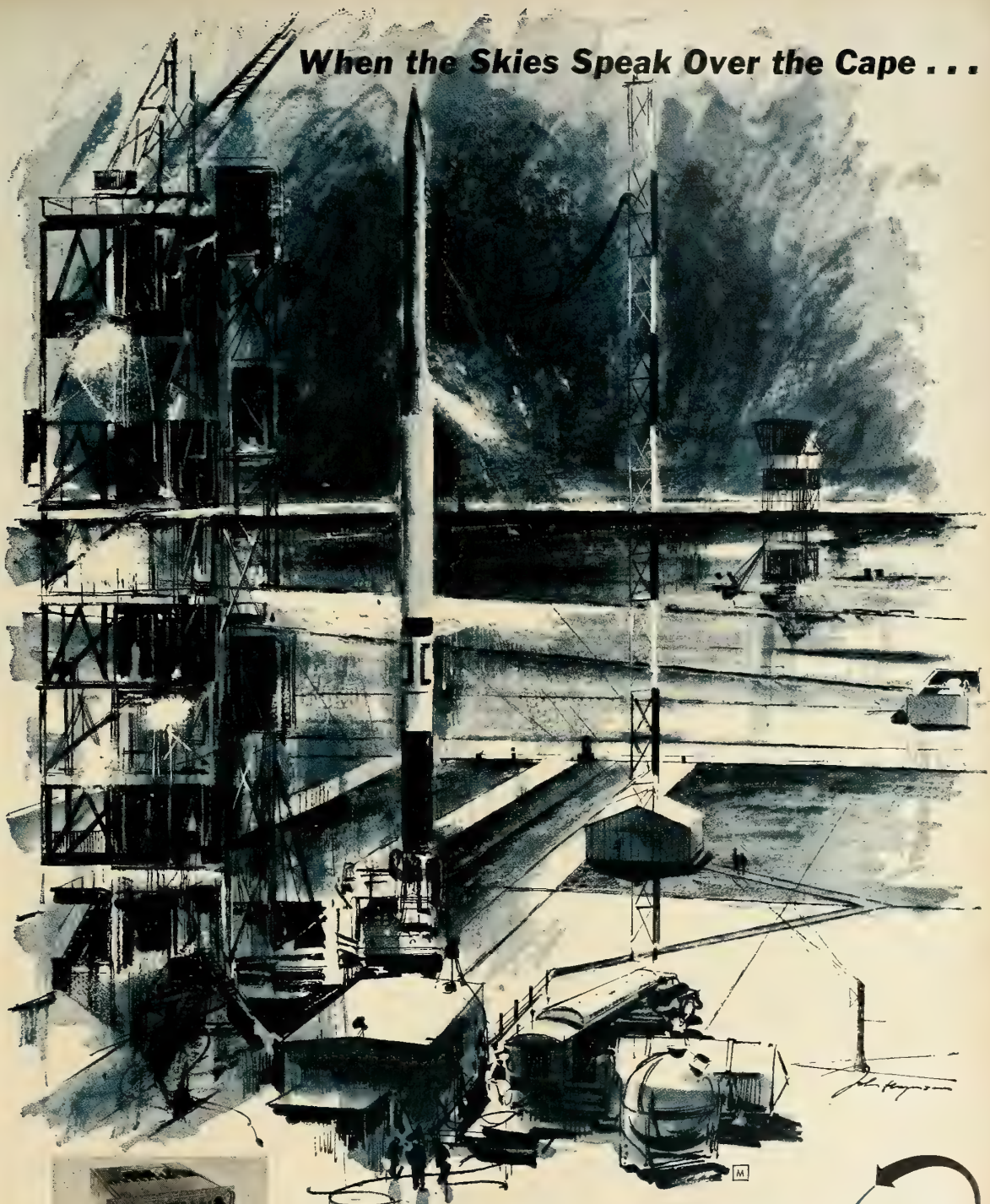
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low temperature targets are best accomplished with detectors having high sensitivity to five or six microns or beyond.

Short wavelength detection employs components and techniques familiar to professional astronomers. The modern design of a photomultiplier tube is a typical short wavelength detector. These phototubes have high quantum efficiency and very low noise.

These devices are commercially developed to an unusual degree of excellence. For example, a typical tube can be built with a cathode area 0.32 in.^{2}, a quantum efficiency approaching 50%, and the spectral sensitivity curve shown in Fig. 3.

The associated optical system may employ either lens or mirror elements, and optical glasses have adequate transparency in the wavelength region concerned.

A typical optical system employs a high speed objective—to image the distant target into a focal plane where modulation or angular discrimination occurs. The radiant flux is then transferred to the sensor.

The resolution and angular capability of the instrument depends on the quality of the objective, and the capability of the associated scanning system. The time constant of the phototube and amplifiers is much less than any mechanical-type scanner can use to full advantage.

Longer wavelength detectors are typically of the photoconductive type. They are characterized by a very small sensitive area, adequate spectral sensitivity, time constancy, and noise limitation. Cells sensitive beyond three microns require liquid nitrogen cooling. The spectral sensitivities of three typical cell types are shown in Fig. 4.

Art detection or observation was limited to low or moderate altitudes, and the useful spectral region has been limited by the intense atmospheric absorption beyond five microns.

This limitation is removed at very high altitudes, and photoconductors sensitive to longer wavelengths are able to exploit the energy which thermal targets emit in the region beyond five microns. This advantage is further emphasized by the blackbody curves shown in Fig. 5.

Typical optical systems used with these detectors include germanium or silicon lenses for the smaller elements, and mirrors for the larger. Because of the very unusual values of refractive index and dispersion which these materials have, the customary simplified optical design methods yield very misleading results. As a result, specialized design techniques are required.

Fortunately, these and other materials can be combined to produce high speed lens systems with satisfactory reductions of the most troublesome aberrations such as spherical, chromatic, coma and astigmatism.

• **The future**—This article has shown that the guidance requirements of missiles and space vehicles pose many new problems, and require new applications for old techniques.

Space vehicles obviously require cells sensitive to longer wavelengths. They also require mosaic cells which can record images simultaneously, rather than sequentially through mechanical scanning devices.

Guidance requires both simple and refined devices for observing angular position, with respect to the earth and celestial objects.

In the case of space vehicles, particularly, refined and specialized stable platforms are required, which will orient our apparatus as desired.

The application of techniques, and the solution of these and related problems, will make possible the more effective guidance of missiles and vehicles in the upper atmosphere and in space.★

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GENERAL	
System	Passive
External energy	None
IMAGE CHARACTERISTICS	
Presentation time	Instantaneous
Resolution	Good
Contrast and tone	Excellent
DETECTION	
Of surface properties	Yes
Of radiant heat sources	Yes
Of hidden installations	Yes
Of camouflage	Yes
FALSE SIGNALS	
Subject to camouflage	Not very readily
Subject to jamming	No
WORKING VALUES	
Suitable to daylight	Yes
Adaptable to night-time	Yes
Range Information	Not direct
GENERAL	
Water vapor penetration	Some, depending on wavelength of equipment
Cloud penetration	Reduces efficiency
Smoke and Haze penetration	Poor at short wavelengths Better at longer wavelengths
OTHER CHARACTERISTICS —Basic Equipment	
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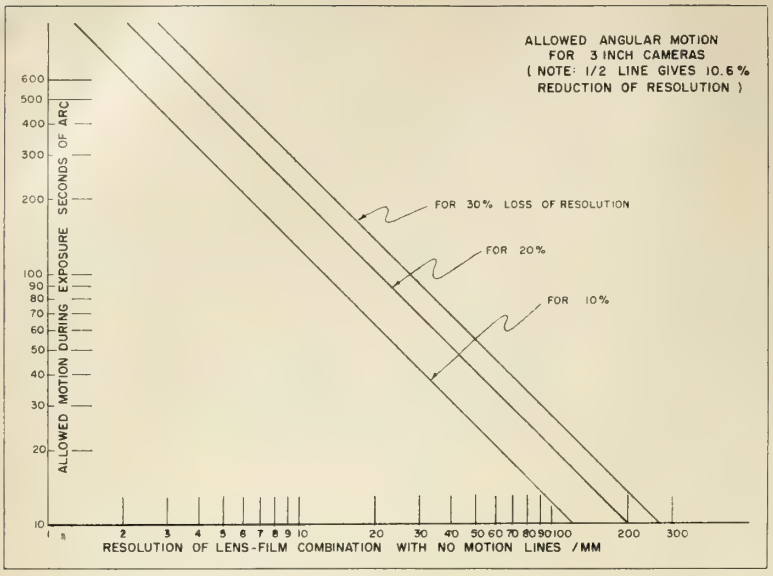
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If Photos are Used for Intelligence:

Cameras Need Stable Mounting

by R. G. Sanders*

INFORMATION CONTENT is the yardstick by which the effectiveness of the aerial reconnaissance photograph is judged. And to judge it properly, these factors must be considered:

The intelligence gained from an aerial photograph or from an infrared recording is directly proportional to the quality and clarity of the picture.

The quantitative means for determining quality or clarity in a photograph is a bar type resolution chart.

The values measured on the negative are read in terms of lines per millimeter.

Currently, standard aerial cameras produce resolutions which vary from 20 lines per millimeter to 35 1/mm, depending upon the lens and film characteristics. Some cameras under development aspire to values as high as 50 1/mm or more. These values are measured in the laboratory on the optical bench.

The intelligence sections of the armed forces want to achieve resolutions, under flight operational conditions, as closely equal as possible to the laboratory capabilities of the aerial cameras. Unfortunately, the vehicles have characteristics which cause the image to be degraded to a fraction of the laboratory test values:

a) Forward motion of the vehicle; b) Roll; c) Pitch; d) Yaw; e) Vibration.

Of the above, forward motion, roll, and vibration are the major factors in image degradation, while pitch and yaw are important but usually of lesser magnitude.

• **Stabilization system**—Protection of image quality from the foregoing degrading factors during operational flights has been responsible for the growth of a highly specialized company—The Aeroflex Corp., Long Island City, New York.

This relatively small company has, for the past fifteen years, devoted its entire research, engineering, and production facilities to insuring maximum information from aerial reconnaissance vehicles by means of specially designed mounting systems.

While current designs are for manned aircraft; the experience, techniques, and equipment directly apply to unmanned vehicles such as reconnaissance drones, missiles, and rockets. Some preliminary designs have been started, to serve special missile and rocket purposes.

Isolation of the aerial camera or infrared sensor utilizing the "shock mount" techniques is adequate for the protection of the physical items of equipment from the destructive effects of vibration and shock.

However, experience has proved that "shock mounts" of various types frequently aggravate image degradation due to vibration. This results from the angular motion imparted to the camera caused by out-of-phase motions at the several supports and by non-centered c.g. location of the camera.

A picture taken during the angular movement of the camera is roughly similar to that produced by a hand-held amateur camera which is carelessly moved during exposure. Further, the "shock-mount" design is incapable of counteracting any of the other degrading factors. Hence, the shock-mount approach by itself has long ago been abandoned.

The only truly effective means of achieving high resolution reconnaissance photography is through the use of a peculiarly specialized stabilization system.

In effect, the sensor is mounted on a stable platform and is fixed in space during the time that the exposure is being made. Thus, very little, if any, angular movement of the camera can take place regardless of the type of disturbing force.

The effectiveness of the stabilizing system is measured in terms of the number of seconds of arc through which the camera rotates during a specified exposure time, such as 1/10 sec., 1/50 sec., or 1/100 sec. The amount of angular motion which can be tolerated without serious degradation to the image varies inversely with the focal length of the lens.

In the accompanying charts, if a 10% loss in resolution in flight is accepted, a photographic system having a laboratory capability of 50 1/mm can tolerate an angular rotation during exposure of 26 seconds of arc for the specified lens. A lens of twice the given focal length would limit the permissible angular movement to 13 seconds of arc. The roll and pitch rates which may be experienced in reconnaissance drones, missiles, and rockets exceed those normally experienced in manned aircraft.

The second chart shows the angular motion of the camera, which results from various degrees of vehicle roll or pitch during any selected exposure time. Unfortunately, it is not always possible to use high shutter speed, which obviously helps the photographic quality. Bad weather or early morning and late afternoon operations require slower shutter speeds.

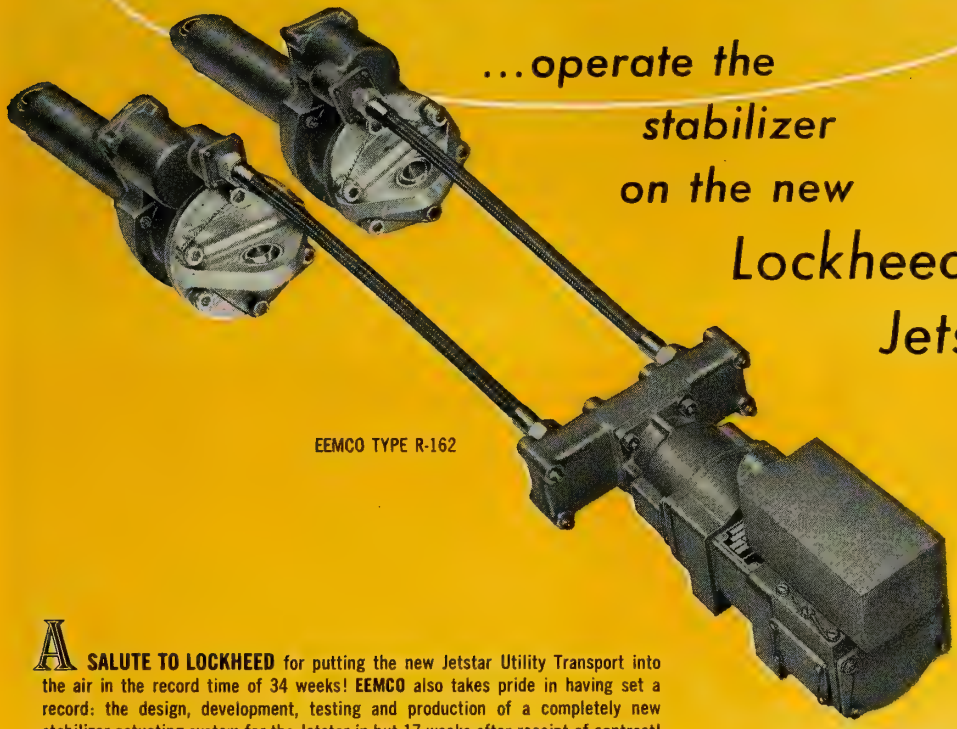
Assuming of 10° roll rate, during which a camera with a 1/100 second shutter speed is exposed, an angular camera motion of 360 seconds of arc would be experienced. Under this condition, a 3" focal length camera with a

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laboratory resolution of 50 1/mm, would be reduced operationally by this one factor to 8 1/mm.

•**Performance analysis**—The Armed Forces specify the type of ground information they wish to detect. From this beginning, the performance required of the reconnaissance system is formulated. At this point, the Aeroflex specialists enter the program to devise a mounting system which will enable the photographic or infrared sensors to meet the resolution requirements under operational conditions. The analysis usually follows a step-by-step procedure:

Forward Motion Compensation—Most amateur photographers are familiar with the problem of photographing a speeding automobile. The same problem exists in reverse in photographing the ground from a fast moving vehicle in the air. This blurring effect of movement can be eliminated by either of two methods:

a) Moving film—In this method, the film is moved during the exposure at a speed which is proportional to the altitude and speed of the vehicle and focal length of the camera. This method usually requires a complex mechanical and electrical design, with attendant maintenance problems. However, where photographs have to be taken at frequencies greater than two per second, it is the only satisfactory method.

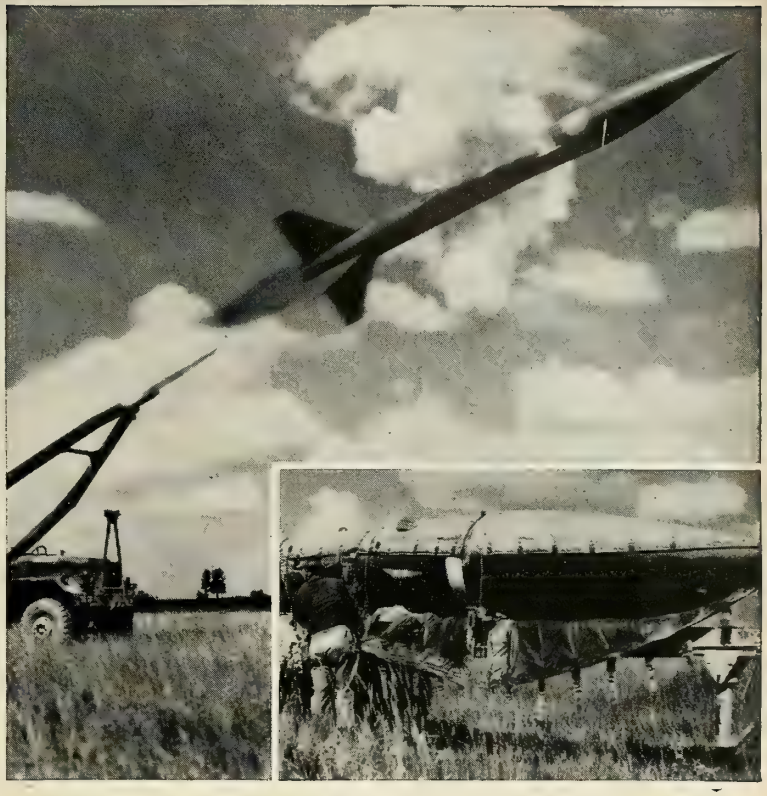
b) Swinging Mount—The deliberate swinging of the camera, at a prescribed angular rate along the ground track of the aircraft, provides a relatively simple means of compensating for the image motion factor.

Roll Stabilization—Although forward motion compensation may be provided, serious image degradation can result from very small roll movements of the vehicle.

Single axis stable platforms have been made for special situations to compensate for this factor.

Pitch stabilization—This factor by itself is usually low in frequency and has little effect on resolution. No occasion has yet occurred to require separate pitch stabilization. However, it can exceed any of the foregoing. A two axis stable platform of special design can minimize or eliminate vibrational image degradation.

This dictates a mount having a roll and pitch capability. Naturally, such a mount for the camera also



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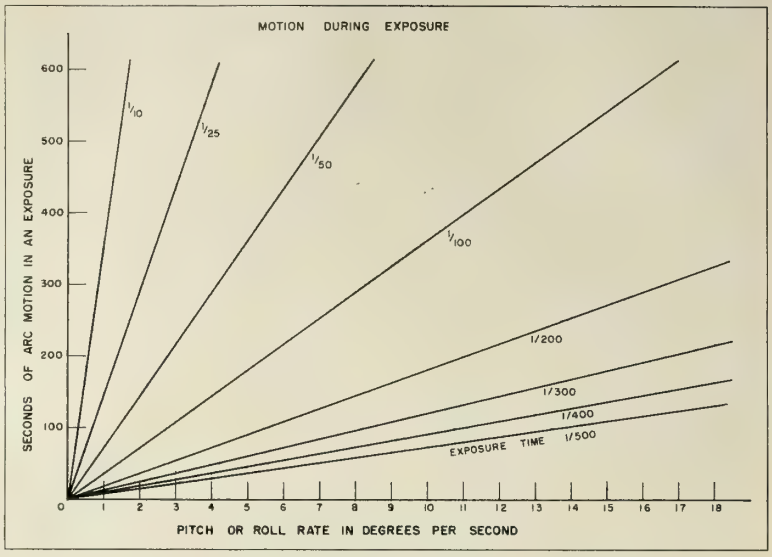
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FACTORS for exposure times, as affected by motion of vehicle.

eliminates the image degradation due to the characteristic roll or pitch of the vehicle.

• **Functions of system**—The maximum protection of the inherent resolution of a reconnaissance sensor which is practical to achieve results from a stable platform must have the following functions: roll stabilization, pitch stabilization, aximuth remotely controlled (not stabilized), image movement compensation either in magazine or in the mount.

Space and weight limitations in vehicles cannot be denied. However, if a vehicle is primarily for reconnaissance, it should be of such size as to permit use of the art equipment to insure the information required by the Armed Forces. For counteracting the angular disturbances due to vibration, the pitch stabilization is equal in importance to roll stabilization.

Yaw Stabilization—A properly designed mount provides (where space envelope permits) a means for varying the azimuth position of the camera, with respect to the longitudinal axis of the vehicle. This provision enables the camera image movement to be parallel to the ground track of the vehicle. Large errors in the rate of image motion compensation can occur from uncorrected vehicle drift, thereby degrading the imagery.

Some sophisticated stabilization systems provide for the yaw motions of the vehicle. This refinement is usually superimposed upon the azimuth movement. However, the degradation to the image due to yaw variations is small, and is not worth the complex mechanism needed to overcome it.

Vibration—Under some conditions, the image degradation results from the vibration characteristics of a vehicle. The situation, involving existing vehicles modified for reconnaissance, makes the space and weight problem very real.

In such cases, the various image quality protective features are sacrificed in the following order: 1) Azimuth correction 2) Pitch stabilization 3) Roll stabilization 4) Image motion compensation.

Of the above, the last two should be retained if at all possible.

• **System components**—Basically, a system for protecting the image quality of a reconnaissance sensor consists of a three gimbal frame for azimuth, roll and pitch.

The mechanical-structural design is of great importance—due to the high sensitivity of the optical system being stabilized. It is in this design area that techniques of design, based upon long experience, are of major importance.

The special reference is mounted on the inner gimbal. This unit is a specially designed vertical gyro. Among its special features are: a) Nulling type b) Extreme smoothness of pick off c) Sensitivity d) Performance in presence of vibration.

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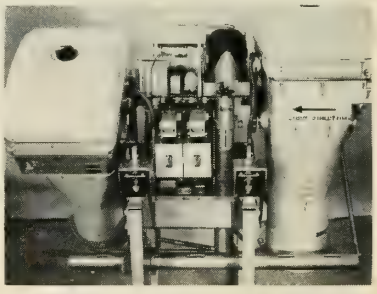
. . . cameras need

vertical gyro due to the coercive effect of bearing friction and cables which must cross the gimbals, is processed through the electronics to torquer motors on the roll and pitch axes.

These torquers are of unusual design due to the critical demands of the optical system mentioned above. The coercion is thus overcome, the error signal is reduced to zero, and the senor is undisturbed within the sensitivity and tolerance of the system.

• **Rocket reconnaissance**—Missiles and rockets are not likely to be called upon to produce mapping type of photography. Thus, verticality only in a gross sense, is necessary for general missile or rocket reconnaissance operations.

Utilizing the ARX-3 type of nulling gyro pendulously erected, a verticality under certain conditions can be achieved to approximately ±30 minutes of arc operationally. There is no data available on performance in missiles or rockets to date.



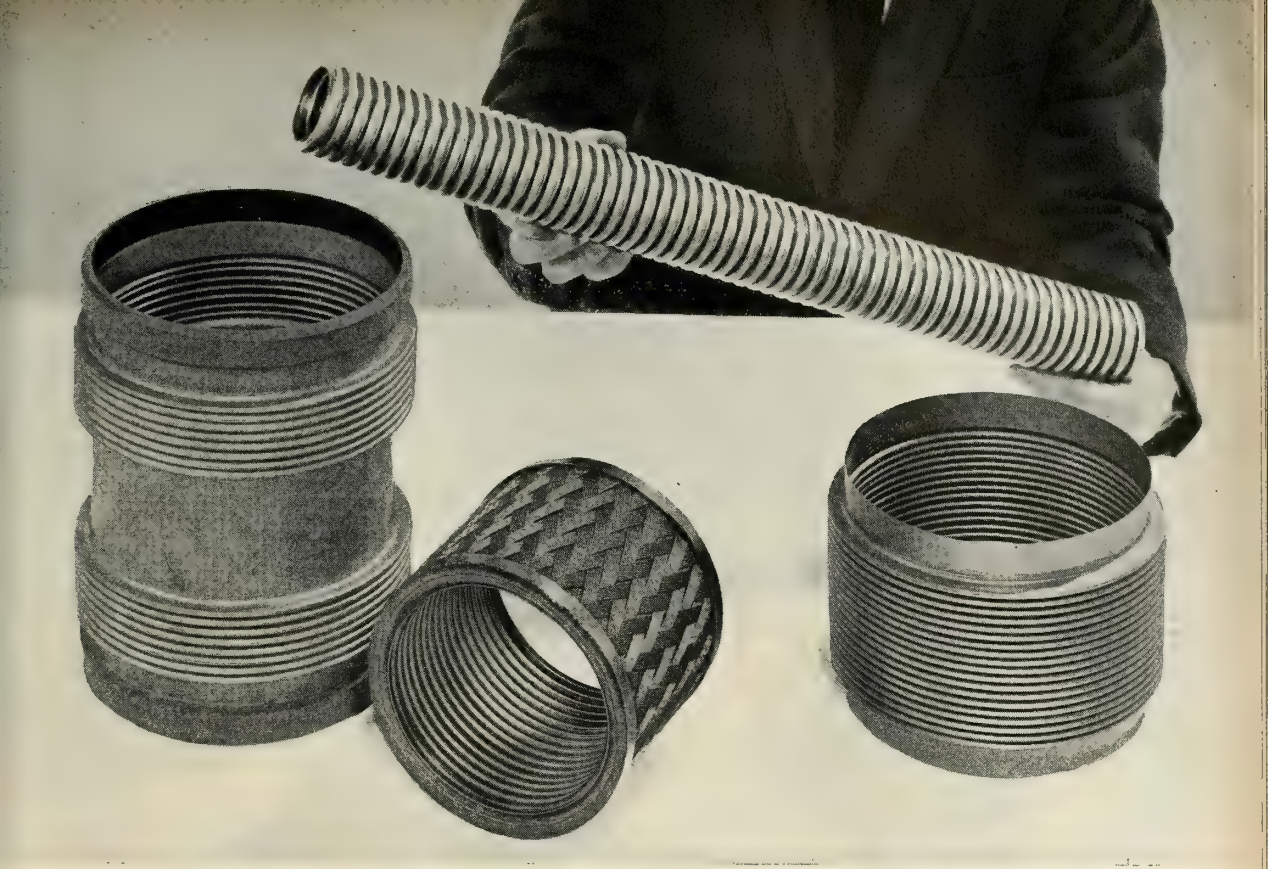
A stabilized torquer mount with image motion compensation accommodating three K-38 cameras.

However, it is conceivable that verticality in the order of ±1½° or 2° could be expected. With more sophisticated vertical reference systems, the probable error can be progressively reduced down to ±3 minutes.

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Standard shelf equipment does not exist in the usual sense. What does exist is a wealth of data based upon theoretical analysis, laboratory and operational test programs, together with specialized circuitry, electronics, gyros, torquers and gimbal structures.

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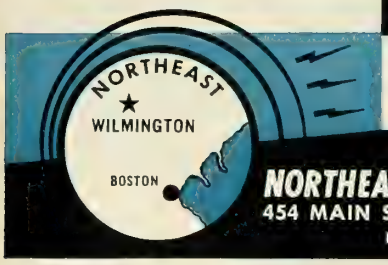
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Tracking System

Fecker Takes On Swiss Camera-Optical Device

J. W. Fecker, Inc., Pittsburgh, a subsidiary of American Optical Company, recently announced that it had been appointed to represent Contraves AG of Zurich, Switzerland, for the sale and service of EOTS (Electronic Optical Tracking System). EOTS, a cine-theodolite system, is now in use in numerous military tracking stations throughout the United States, and more units are scheduled for installation in the near future.

Employing two or more cine-theodolites synchronized by a master station, the EOTS requires a two-man operational crew. It is used primarily for obtaining accurately-timed position information of airborne objects on 35 mm film, recording their angle values in relation to the EOTS system.

According to J. W. Fecker, Inc., the EOTS is considered the most accurate tracking cine-theodolite system in existense today, with an unreduced accuracy equal to the reduced accuracy of other comparable systems.

The actual dynamic performance of the EOTS has been shown to have an error substantially less than 5 seconds of arc. This accuracy is possible when all systematic errors have been taken into account and the equipment is operated under the proper environmental conditions.

The vernier arrangement for reading angle information is such that 1/1000 of a degree may be estimated.

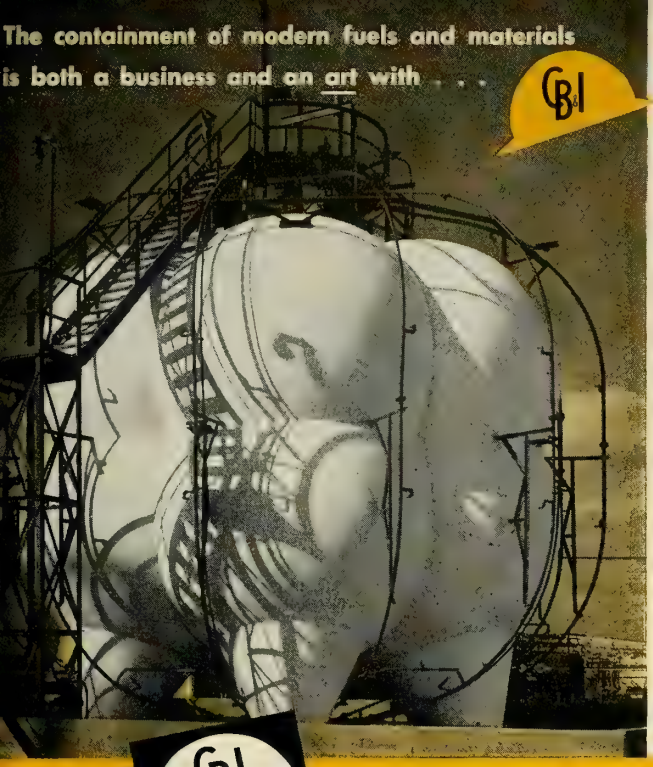
The position of the target is obtained by three-dimensional double projection. For this purpose, the elevation and bearing at which the target is seen from an accurately-established base line on the ground are measured and recorded by at least two units simultaneously. The larger the trajectory to be studied, the greater the number of units to insure accuracy in all measurements.

In the missile field, the EOTS records such special data as engine ignition phase, booster separation, combustion burnout, impact phase, and detonation of warhead, in addition to trajectory and flight attitude.

Synchronization of each unit is achieved by the master station which transmits impulses through a VHF-FM radio link or by cable. Its design allows control not only by its two operators, but also by radar or a computer; the latter being used for target acquisition in tests over very great distances.

The 35 mm camera may be set to take photographs at frame rates up to 32 per second, and holds 1,000 feet of film.

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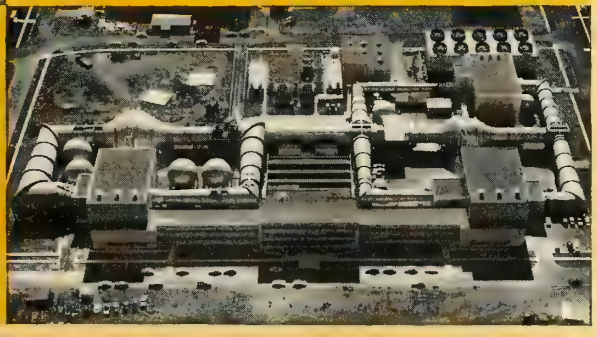
See CBI for Creative CRAFTSMANSHIP IN STEEL











TOP, LEFT—14-lobe MULTISPHERE designed, fabricated and erected by CB&I to store 100,000 gallons of liquid methyl chloride at 150 lbs. working pressure. Design offers optimum versatility for pressure vessels.

A—5052 ALUMINUM was used for these ammonium nitrate storage tanks.

B—LIQUID PROPANE is stored by refrigeration at 1½ lbs. working pressure at minus 44° F in this unique 70-ft. diameter tank, designed and built by CB&I.

C—MULTICYLINDER Multi-lobe pressure vessels such as this offer advantage of high pressure storage where space is limited. Vessel is designed for 250 lbs. working pressure.

D—VACUUM SERVICE is provided by Hortonsphere® at a University of Toronto wind tunnel installation.

E—TUNNEL SECTIONS for wind tunnel were fabricated and erected by CB&I. A supersonic wind tunnel for Convair Division of General Dynamics was recently completed by CB&I as a "turnkey" project.

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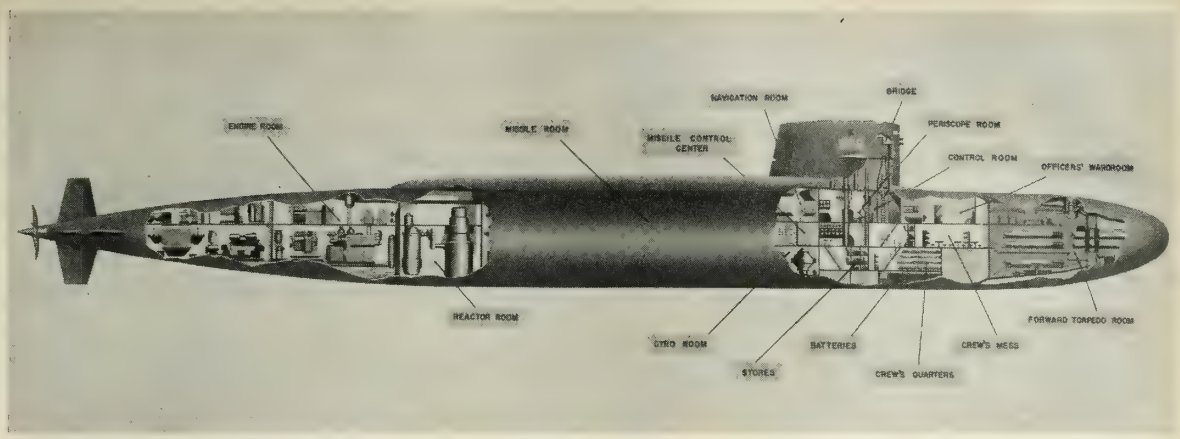
SPECIFICATION SUMMARY

	Single Ended Input	Differential Input
Gain:	Fixed gain set to any value from 10 to 1000 inclusive by front panel plug-in units. Gain switching plug-in attenuator available with gains of 0, 10, 20, 50, 100, 200, 500 and 1,000. Adjustable upward 6db from setting with potentiometer.	Fixed gain set to any value from 10 to 1000 inclusive by front panel plug-in units. Gain switching plug-in attenuator available with gains of 0, 10, 20, 50, 100, 200, 500 and 1,000. Adjustable upward 6db from setting with potentiometer. (Fixed gain plug-in units only.)
Input Impedance:	100 megohms shunted by 0.001 mfd (typical).	10,000 ohms.
Source Impedance:	5K or less (to meet noise specification).	
Drift:	Less than 2 microvolts in 200 hours at constant ambient temperature. Less than 0.4 microvolt per degree centigrade.	Less than 2 microvolts in 200 hours at constant ambient temperature. Less than 0.4 microvolt per degree centigrade.
Ambient Temperature:	0° to 50°C.	0° to 50°C.
Noise (Referred to input):	0-3 cps 5 microvolts peak to peak 0-750 cps 4 microvolts rms. 0-50 kc 8 microvolts rms.	0-3 cps 10 microvolts peak to peak 0-750 cps 6 microvolts rms. 0-50 kc 11 microvolts rms.
Frequency Response:	±3db to 50 kc (typical); ±1.0% to 2 kc	±3db to 50 kc (typical); ±1.0% to 2 kc
Output Capability:	±10 volts at ±100 ma DC or peak AC to 10 kc	±10 volts at ±100 ma DC or peak AC to 10 kc

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FBM Submarine: Ultimate Weapon?

by William O. Miller

IF ONE SCHOOL OF THOUGHT has its way, the entire U.S. Navy, with the exception of submarines and certain supporting forces, will be "torpedoed"—by U.S. submarines.

They are the military philosophers, both in and out of the service, who insist that the day of ships and weapons that have to operate on the surface is just about over. This includes not only the ships of the fleet, but the vast merchant marine which today transports practically all the world's goods.

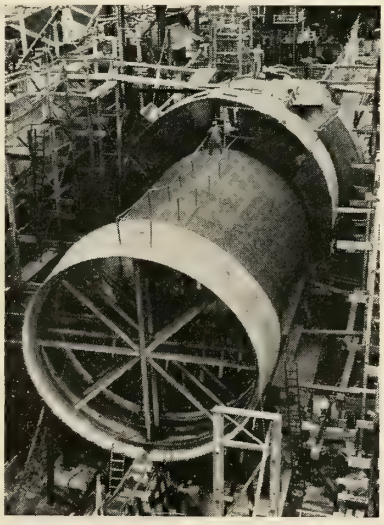
Not for the first time in its history, but in a peculiar way, the influence of this group has helped to place the Navy on the horns of a dilemma. The focal point of this dilemma is the rapidly rising star of the Navy team, the submarine, and particularly the *Polaris* or Fleet Ballistic Missile submarine.

For the past several months there has been a steady parade of top Naval officers and civilians to Capitol Hill to testify before members of the House Subcommittee on Appropriations. They have testified in detail on the overall program, with emphasis on the submarine program. The Navy had asked, via the Department of Defense, for nine FBM submarines which would utilize the *Polaris* missile.

While the same witnesses had to "sell" as hard as possible in hopes of getting the money needed to carry out the program, they were producing ammunition for the zealous submarine supporters. Sub supporters declare that the submarine is the only type vessel the Navy needs, and all else is well down the road to being obsolescence.

• **The system,** which saw its birth after the now famous fight headed by Rear Admiral Rickover, had its ups and downs until the first nuclear powered boat, Nautilus, was delivered and proved herself beyond all expectations. The second factor was the high speed and maneuverability capabilities resulting from the development of the Albacore configuration.

The third and final part of this system which brought it to its present top priority position is the *Polaris* missile, announced a year and a half ago. All the components, and the FBM system as a whole, have been the reason for justifiable enthusiasm and support by the entire Navy, as well as the submariners.



THE FIRST FBM submarine being built at the Electric Boat Groton Shipyard.

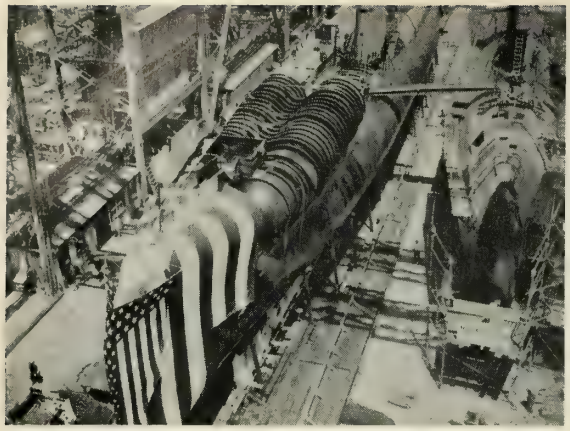
• **The case for** the submarine is a strong one. There's no arguing with the submarine's greatly increased speed and maneuverability, its practically unlimited range and cruising ability and the nuclear missiles and torpedoes shortly to come. It's greatest asset is the ability to disappear into the vast ocean depths and proceed to carry out its mission in any part of the world.

Those who want a more diversified fleet readily admit the facts for the submarine speak for themselves. But the extremes to which some of the submarine enthusiasts go approach what might be termed "deep blue yonder" ideas. The claims they make basically are true, but many of them are projections which may take a number of years.

They claim it is necessary to go under the sea with everything because we won't be able to control the surface. As one high ranking officer in the Pentagon commented, "If we don't control the surface of the seas, we won't be controlling much of anything else, anywhere, anyhow."

Sonar research is a big item in the Navy program. This is particularly true of the deep sonar research because of the increasing depths that modern submarines can go to and associated unknown sonar conditions.

As a means of both detection and identification, it is extremely important insofar as anti-submarine activities by



REGULUS II stowage is on the forecastle of the Grayback, first of six new guided missile subs employing Reg I or Reg II.



GUIDED MISSILE submarines in either fleet, the Tunney and the Barbero were first of type with Regulus I capability.

submarines increase with development of more sophisticated weapons such as *Subroc*.

In discussing deep sonar, Rear Admiral L. D. Weakley, CNO's Anti-Submarine Warfare Readiness executive, pointed out the advantages of lower depths.

"While sea water is a good conductor of sound, many factors enter its effectiveness and reliability as far as evaluating and actually knowing what you have," he said. "The salinity of the water, temperature layers, activities of marine life and many other vagaries must be taken into consideration. This is particularly true the nearer you get to the surface."

Admiral Weakley went on to explain that in greater depth a higher frequency can be used and the band narrowed, which eliminates some of the background noise so prevalent nearer the surface.

The ardent submarine promoters brush aside or ignore a number of difficult problems. Rear Admiral Weakley described the submarine as deaf, lame and blind.

"The increased speed and maneuverability, plus extended range, brought on by the Albacore configuration and nuclear power plant, has greatly diminished the lameness, continuing improvements in sonar is alleviating the deafness, but we are in urgent need of a better detection and identification system," he said.

While the idea of transporting all ocean-borne cargo by submarine or submarine-towed barges is perfectly feasible, it is fantastically expensive. Best estimates are that the cost per ton mile for submarine cargo is about 30 times that for cargo carried by surface ships.

Sonar contacts have been made at ranges up to 80 miles, but this was under optimum conditions and is not the average by any means. One of the Navy's top priority programs is in sonar research and development, which one admiral presently describes as an opaque system.

• **A balanced fleet** is the aim and desire of the majority of the top people who are responsible for operating the Naval Establishment. They argue the Navy has but one purpose—to serve as a deterrent to aggression anywhere in the world, and to maintain control of the seas in time of emergency or war, if it should come.

It is conceded that the FBM submarine with its *Polaris* missile will be one of the greatest deterrents this nation will have. However, the official Navy position recently was summed up by Admiral Arleigh Burke, Chief of Naval Operations:

"Control of the seas requires a very diversified naval force to counter any threat to our use of the seas, no matter what it is. This takes more than a single approach to naval weapon planning. This is important—for it is all too easy to become fascinated with the possibilities of new and revolutionary weapons systems and forget the more conventional things that continue to be equally essential to control the seas."

A variety of methods of attack is the aim of the Navy, not only in weapons systems but in the missiles themselves. Rear Admiral K. S. Masterson, Director CNO's Guided Missile Division, pointed out that while developments usually mean the phasing out of less sophisticated missiles, it is advisable to keep on hand certain slower lower flying birds to give the desired variety.

Admiral Masterson likened military planning to playing a game of chess.

"If a nation has to defend against an attack and it is known that the attacking force would use only one type of method and one means of delivery—then his problems are decreased manyfold. If he must defend against many types of attacks, then he must devote his resources and manpower to many weapons and many defense systems.

"This may be likened to a chess game whereby we have only one method of playing. The opponent will quickly devise a defense to stop this plan of attack. This defense would be followed by a rapid checkmate. No stalemate or stand-off."

Long range planning is in keeping with the team concept and mutual exploitation of the advantages of a variety of weapons and systems and goal.

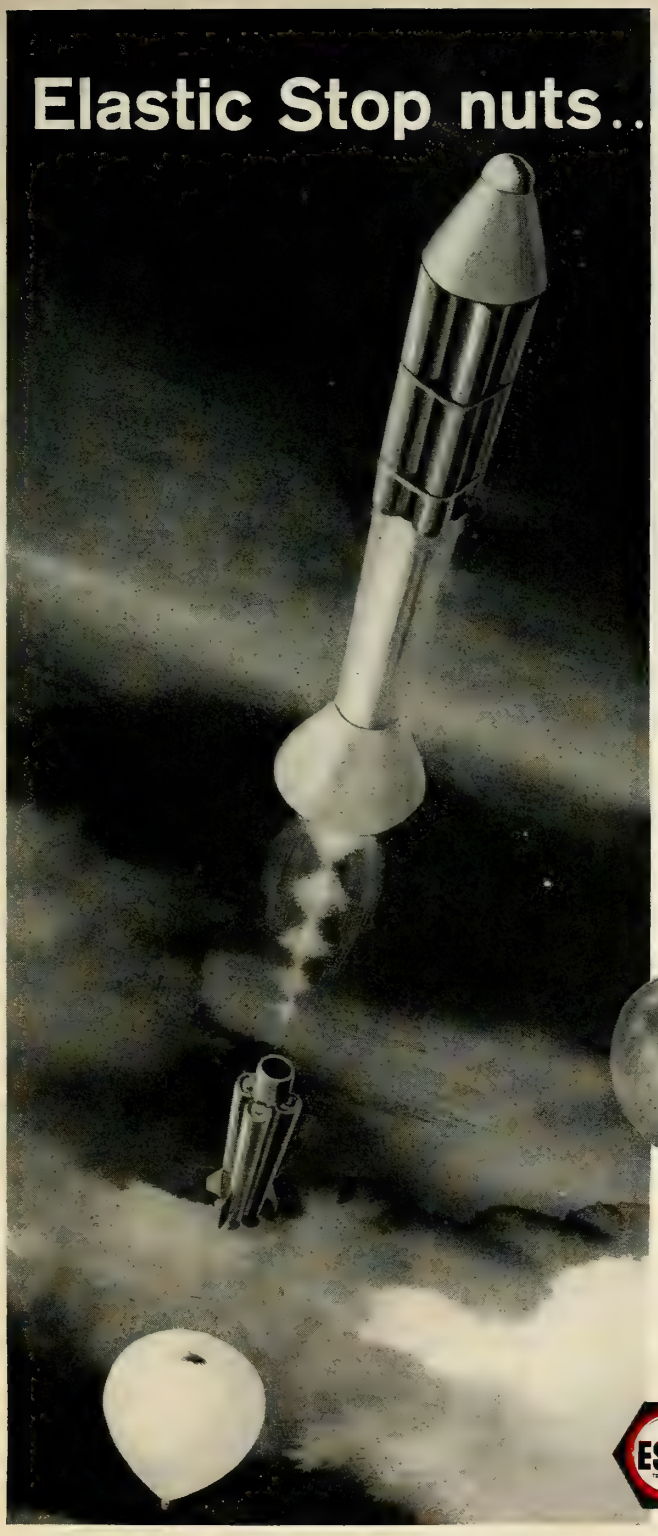
• **Five boat programming** is the pace set for the initial series of the Fleet Ballistic Missile submarines. The Department of Defense has asked for two additional boats, in addition to three already authorized.

A considerable part of the time Navy witnesses spent testifying before the House appropriations Subcommittee was devoted to the *Polaris* missile and the FBM submarine program.

After questioning three witnesses, the lawmakers finally found out who actually made the decision to request only two additional FBM submarines in the supplementary budget, instead of six additional boats as recommended and asked for by the Navy.

Assistant Secretary of the Navy (for financial management), J. Sinclair Armstrong, told the committee that the nine boat program had been recommended to the Department of Defense by the Secretary of the Navy,

Elastic Stop nuts.. *make first trip to the exosphere*

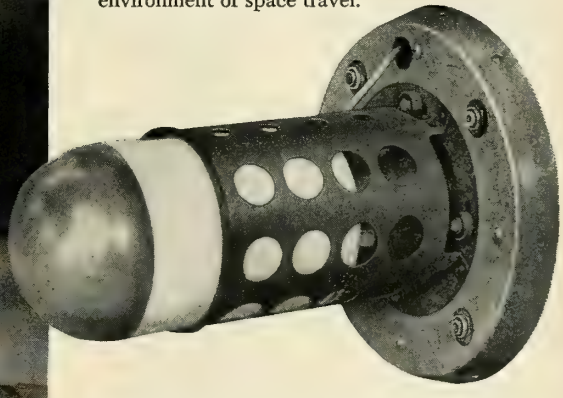


An artist's version of the launching of the Far Side rocket. The four-stage vehicle was carried to an altitude of 100,000 feet by a polyethylene balloon made by General Mills. Fired straight up through the balloon, Far Side rocketed to the greatest distance from the earth ever reached by a man-made device. The prime contractor for the Far Side project was Aeronutronic Systems, Inc., a subsidiary of the Ford Motor Company, for the Air Force Office of Scientific Research (ARDC).

What were the requirements for an exploratory trip into the exosphere? The success of project Far Side established these two among others:

1. A launching platform located as far as possible above the effects of atmospheric drag
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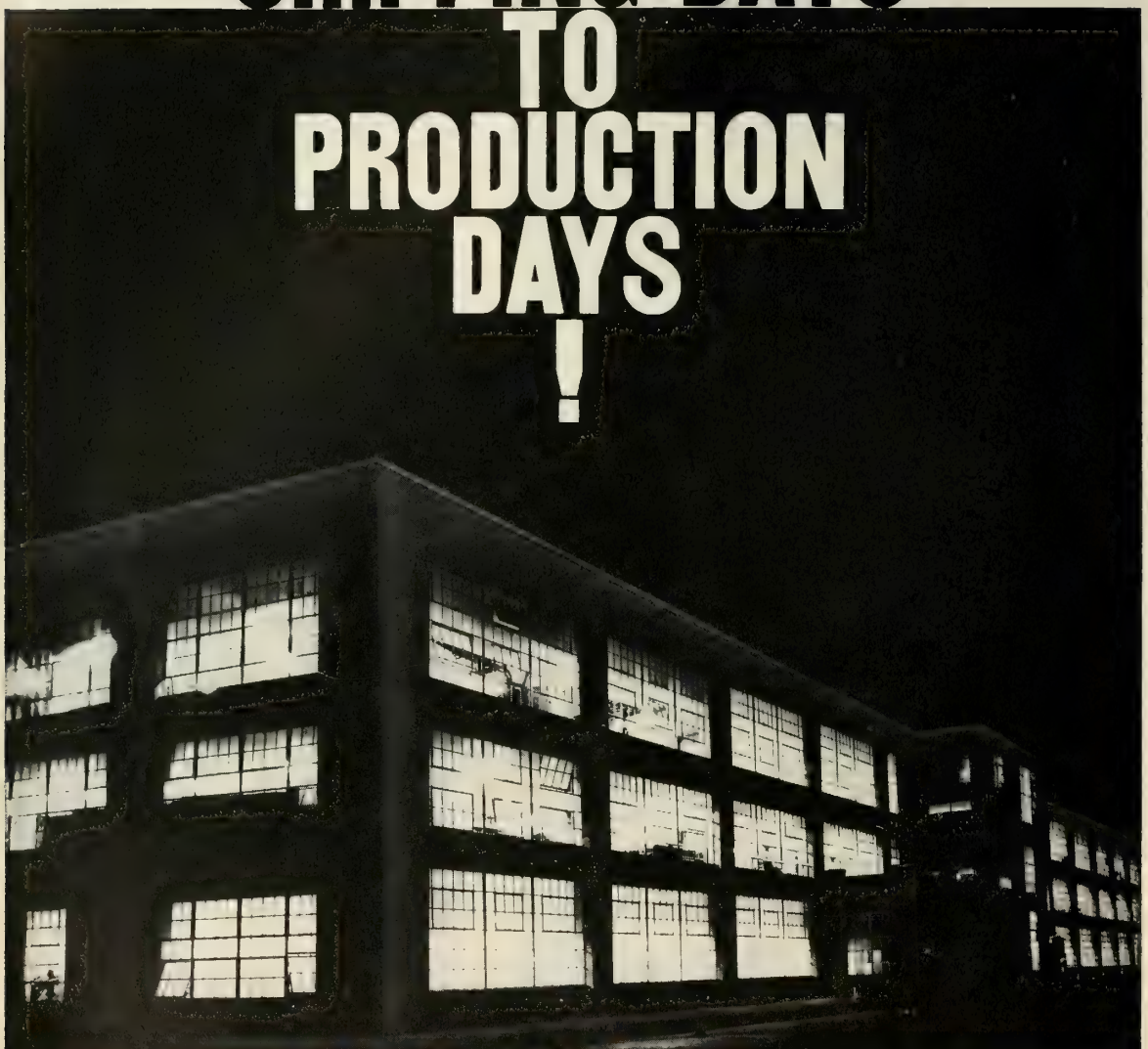


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but he wasn't sure who exactly cut the number to two boats.

The second witness, some time later, Assistant Secretary of Defense (Comptroller) W. J. McNeil, said he assumed it was the decision of the Secretary of the Defense and the President, based on the recommendations of the Joint Chiefs of Staff.

Finally, when Secretary of Defense McElroy appeared and was asked who had made the decision he said:

"It was a decision made by Mr. Quarles and myself. What ultimately happened was we submitted this to the Joint Chiefs of Staff for consideration and this had the concurrence of the Joint Chiefs of Staff."

McElroy went on to say the JCOS were not asked to consider the advisability of more than the two additional submarines, and that they approved the decision and the budget as a package.

One of the committee members asked the Secretary what would be the financial gamble between the time the money was appropriated for the four more additional boats the Navy wants, and the time positive test results would be available on the *Polaris* sub. The question followed an explanation by McElroy as to why the B-52 program was selected for an increase in numbers, whereas the *Polaris* program was not.

The Secretary said the decision was made because the B-52 is considered a proved weapon which is available now and the *Polaris* FBM submarine is considered a prospective weapon, and that there is a time gap before we will have a completely tested and proved reliable long-range missile.

On the assumption that such tests would be completed by December 1959 and that the submarines were laid down this year, the estimated loss, McElroy said, could be held to a range of between $25 and $30 million for ordnance and vessel costs.

He went on to say that no loss would be incurred for the missile and support equipment procurement since these funds would not be fully contracted. Only several million dollars would be lost because of special tooling.

The above estimates were made on the following assumptions: construction awards for the four submarines concerned would be awarded during the first two quarters of the fiscal year 1959; none of the specialized fleet ballistic missile equipment would be



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R-119-5	11	.60	6200	115/40V	A3106
R-110-5	15	1.45	5000	115/40V	A3106
R-111-5	18	2.4	4800	115/40V	A3104
R-112-5	18	2.8	9800	115/40V	A3104
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. . . FBM submarines

installed by December 1959; the navigation and missile checkout equipment on order would be applicable to other Navy programs without loss; and that missile production facilities would be substantially completed by December 1959, but would in large part be useable for other programs.

It was estimated that it would cost about $852-million to complete the four additional subs the Navy wants for its nine-boat program. So far, about $1.4-billion has been authorized for the *Polaris* program.

• **Testimony in detail**—Rear Admiral W. F. Raborn, who heads up the *Polaris* FBM project, was questioned at length as to the optimum program and stood by the nine-boat recommendation that went to the Department of Defense.

He explained this was based on the availability of shipyards without disrupting other high priority construction work, the procurement of additional missile production facilities without undue overtime prices, and the ability to produce missile components without going into large expenditures to produce numbers not yet fully tested. Raborn said that while he would not consider the nine boat program a crash program, a 15-boat program would be one.

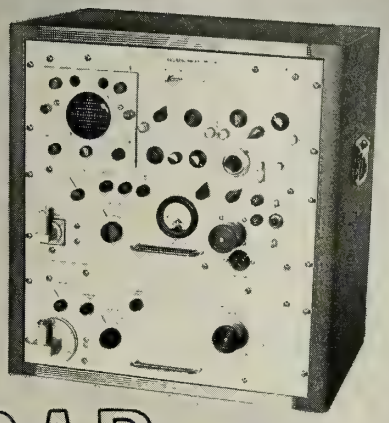
Although a complete *Polaris* missile has not yet been tested nor yet coupled with the submarine, Admiral Raborn expressed the utmost confidence in its success because of successful components tests. He said now it is largely an engineering job.

The acceleration of the *Regulus* II and *Snark* development as interim program came up for discussion during the Secretary McElroy's testimony. McElroy said no attempt was made to accelerate these two programs because the Navy and the Air Force did not consider them of high priority for acceleration, in relation to the remainder of the ballistic missile program.

McElroy also said that he agreed it was the opinion of the Joint Chiefs of Staff and the Department of Defense that despite time which must elapse before the advent of the *Polaris* operational capability and other missile power, the Services have ample destructive power without accelerating either the *Regulus* II or *Snark* programs.

Regulus II, meanwhile is planned for six submarines. They probably are the Grayback, which was completed at Mare Island in March; the Growler,

X and C band

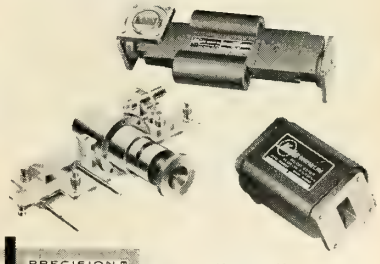


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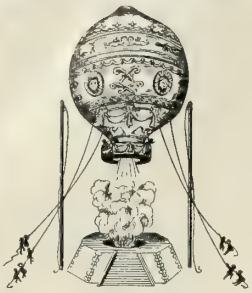
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The Montgolfier Brothers

The first really significant phase in man's conquest of the space above him began in France with the ballooning era of 1783. It was in June of that year when Joseph and Etienne Montgolfier demonstrated their first successful balloon—a 35 foot diameter linen lined paper bag filled with hot air. It reached an impressive altitude of 6,000 feet over Annonay, France.

After several experiments with domestic animals as passengers, the Montgolfiers achieved their ambition of transporting humans in a *free flight* balloon. On November 2, 1783 a Montgolfier balloon was set free from its "launching platform" in Paris, carrying as passengers Pilatre de Rozier and the Marquis d'Arlandres. The balloon rose majestically to more than 3,000 feet and traveled a distance of 5 miles in 20 minutes. The fuel used for that history-making flight was straw, burned to heat the air in the bag. For safety, pails of water were carried to extinguish any possible fires.

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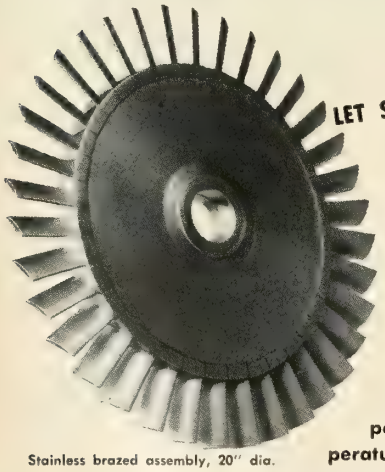
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. . . FBM submarines

completed last fall at Portsmouth, and four nuclear powered boats, the Halibut, Pollack, Permit and Plunger.

Presently two submarines are equipped with *Regulus* I, Tunny and Barbero; however, the *Regulus* I program is in the process of being phased out.

• **Contracts awarded**—Contracts have been awarded for three FBM submarines. Two are being built by General Dynamics and one at the Mare Island Shipyard. There has been no indication as to who will get the contracts for the two additional FBM boats asked for in the supplemental appropriation.

Keels for two more nuclear powered submarines were laid last month at General Dynamics' Groton shipyard. They were for the second FBM sub awarded the Electric Boat Division and for the Tullibee, an anti-submarine submarine.

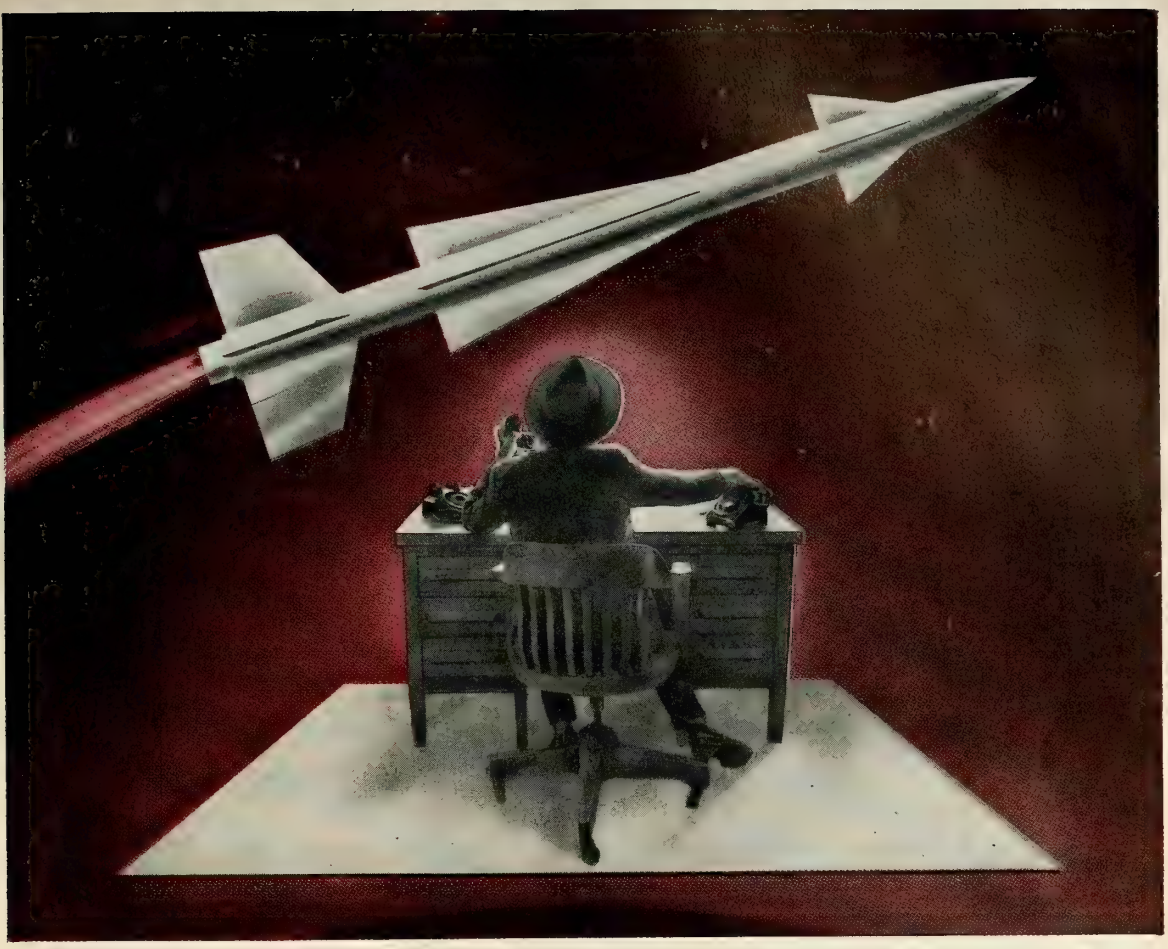
It was from this same yard that last week the Skipjack, first of the single screw modified Albacore configuration boats, was launched. Also under construction at EB's Groton shipyard is the Triton, the first reactor submarine and largest submarine ever constructed, some 7,200 tons. The Triton, a radar picket sub, will be launched this summer.

A total of 17 nuclear powered submarines are authorized or under construction. Nuclear powered boats are being built or are authorized at General Dynamics' EB yard at Groton; U.S. Naval Shipyard at Mare Island and Portsmouth; Ingalls Shipbuilding Company, Pascagoula; and Newport News Shipbuilding and Drydock Company, Pascagoula; and Newport News Shipbuilding and Drydock Co. The last of the diesel powered boats are building or authorized at Ingalls; New York Shipbuilding Corporation and Portsmouth.

Six of the guided missile submarines now under construction will be equipped with the latest anti-submarine torpedoes and *Subroc*, when it is developed to make them the nation's most potent anti-submarine weapons.

At present, there are 113 submarines in service. This number will drop some as new boats are commissioned, but the number will remain substantially the same because of training requirements. Of the 113 boats now in service three are nuclear powered.

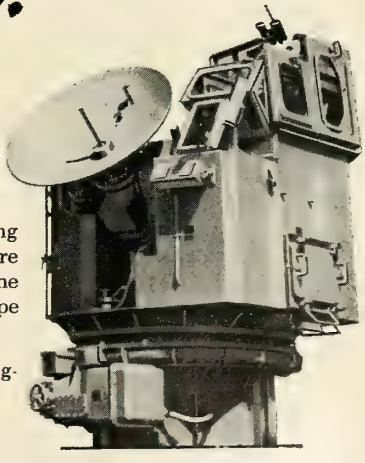
The Navy has a sizeable submarine fleet in mothballs, but most are of World War II vintage.★



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CAMERA HELPS RECORD the firing of a 5,000-pound thrust high-energy fuel rocket.

Cameras: Top Testing Tool For Missiles

Instruments taught new tricks in order to spot trouble at speeds far beyond the ability of human eyes to record

by Peer Fossen

PHOTOGRAPHY, long established as a prime recording means for industry, has acquired some new tricks to keep pace with advances in projectile performance and velocity. As a result, the camera has become a key research tool for qualitative and quantitative study of missile test phenomena.

Whatever happens too fast for the eye to see, too fast to follow, too dangerous to watch directly, or occurs too far off to view directly, is in photography's domain. In short, when missile engineers want answers to "what, where, when, how and why" in connection with the performance of their "birds," photography can help supply these answers.

• **What?**—What actually happens inside a rocket thrust chamber is of prime interest to the engine development engineer. Recently, engineers at one major rocket engine firm developed a simple photographic system for pinpointing fuel droplet phenomena inside a combustion chamber.

Windowing a test rocket motor with quartz, the men constructed a strip-camera set-up which froze the rapidly-moving droplets on a superfast photographic emulsion.

The droplets—less than 100 microns in diameter and moving through the chamber at 100 feet per second—proved to be a challenging subject. Designing a lighting source which provided sufficient contrast between the translucent droplets and the white-hot combustion zone, the engineers shot at the rate of two microseconds per exposure.

Result: a sequence record of droplet phenomena answering such questions as change in droplet diameter, rate of droplet formation, evaporation, droplet velocity, and the pattern of droplet distribution.

The same firm also developed an ingenious oscillographic recording and color photography combination. Proceeding from the premise that the more phenomena that can be simultaneously recorded and selectively interpreted the better the testing—instrumentation engineers set about untangling the maze of interlocking oscillographic trace sweeps.

Filters of selected densities and colors were used to capture the intercrossing oscillographic trails on a specially spooled roll of Ektachrome film, 200 ft. long and seven inches wide. According to the company, as many as 18 intermeshed trails of varying hues have been pin-pointed for individual study.

Results of such early investigations into color oscillography suggest the possibility of employing color negative material, true panchromatic print paper, and appropriate filters for selective black-and-white records of individual oscillographic traces.

Further, in connection with rocket engine performance studies, photography has been employed to by-pass the hazards of close-up viewing of volatile missile propellant combustion.

High-speed movie cameras positioned obliquely 20 to 50 ft. behind rocket engine exhaust areas are slowing down combustion phenomena for subsequent study and evaluation. Operating at speeds up to 5,000 frames per second, the cameras are contributing valuable information on the characteristic flame patterns of a wide variety of propellants.

At one USAF flight test center, close to 100 such motion picture cameras are employed. These cameras photograph engine start and shut-down, flame patterns, after-burning, etc., exhibited by rocket engines developing up to 1 million lb. of static thrust.

• **Where?**—Regardless of whether a missile shoot is a success or not, those charged with responsibility for the project want to know where the vehicle went. One of the prime means of missile tracking is the theodolite. Adding the dimension of motion picture photography, cine-theodolites record on film the exact azimuth, slant elevation, and bearing of projectiles under observation.

Result is a photo-record of the projectile with appropriate location information included on each numbered frame of film. In current wide-spread use in theodolites is a World War II development—Kodak Linagraph Shellburst film, which possesses the necessary contrast capabilities and red sensitivity for effective tracking of the transonic projectiles.

The chief advantages of cine-theodolite photography are:

1) Information as to exact positioning of missile when adverse phenomena occur; 2) data concerning effective ranges of tracking films used under a wide variety of atmospheric conditions; and 3) accurate plotting information as to impact area, thereby facilitating the solution of recovery problems.

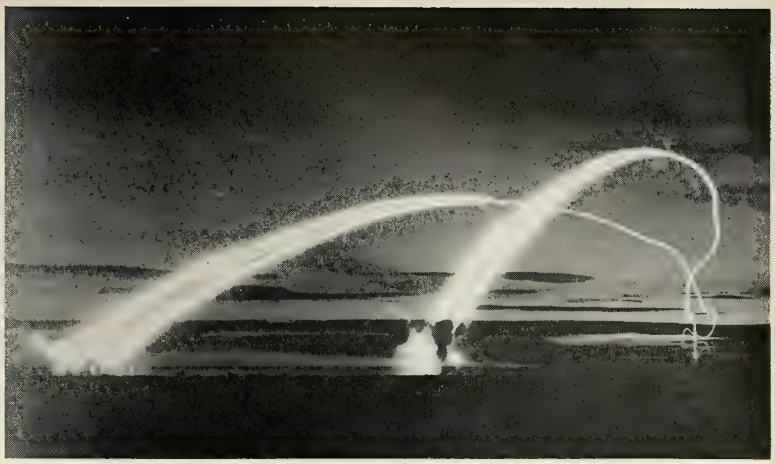
• **When?**—When deterioration occurs during the transonic phases of missile flight testing, the ability of photography to expand transistory action aids later evaluation.

The jet-sled, well-known for its contributions to ejection seat studies, has also proven its value in destructive testing of experimental missile components. At one high-speed track, sleds are propelled down a 10,000 ft. precision aligned railroad track at speeds in excess of Mach 2.

Effects of speed, acceleration, and deceleration on structural members and internal missile components are recorded by cameras operating at speeds of 24 to 1,500 frames per second. Subsequent review of the films enable the technicians to pin-point the occurrence of a breakdown.

• **Why?**—When transonic projectiles go awry and do not carry out assigned missions, it is of prime importance to determine "why." Here, too, photography has been playing a key role.

For example, detective work in the area of fuel leakage is receiving a tangible assist from conventional color photography. Using substantially the same film familiar to amateur photographers, project engineers trace the effects of fumes and leakage of red fuming nitric acid rocket fuel by covering the aft section of the vehicle with



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. . . cameras

acid-reacting paint, noting the corrosive effect indicated on the subsequent photo-color records produced.

Another key problem area—why missile skins exhibit changes in surface characteristics at high temperatures—is under photographic examination.

In ground test laboratory facilities, test coupons of missile skin materials, such as commercially pure titanium and manganese alloys, are subjected to selected time and temperature steps. The resulting changes in coupon color are then recorded in chart on color prints.

Thus, spot field comparison can be made, followed by laboratory evaluation of characteristic missile skin colors of retrieved missiles. Color print-charts are used as indicators of the approximate temperature conditions by the test missile.

One of the problems associated with the night firing of ballistic-type rockets is the momentary flash blindness experienced by many pilots at the moment of release. Engineers made photometric measurements of the blast effect and were able to develop counter measures accordingly.

• **How?**—In order to check how internal missile components operate, many missile technicians employ photography. One company in the rocket engine field makes use of a high-speed camera at film speeds up to 180 feet per second to check out electrical circuit performance in guided missile components.

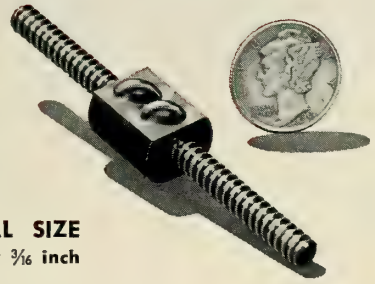
Known as a streak camera, the unit monitors pattern response directly from the cathode ray tube under conditions varying from no load to full load. Data reduction is accomplished by using the film's velocity through the camera as a time base, enabling examination of ripple voltage traces of prototype transformer-rectifier components on varying time scales.

Various types of film are used in the high-speed streak camera, depending on the type of phospor in the oscillographic display screen involved.

As might be expected, some problems are encountered when a camera, built to withstand no more rugged shocks than the jouncing encountered in the back of a pick-up truck, is destined for internal mounting in a missile. Where peak acceleration loads of 200 g's are anticipated, special camera construction adapted to withstand transonic vibration and gravitational phenomenon is indicated.

Work is currently progressing on special photographic equipment for in-

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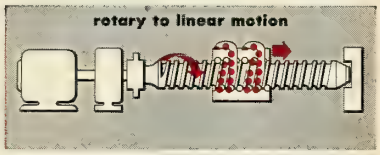
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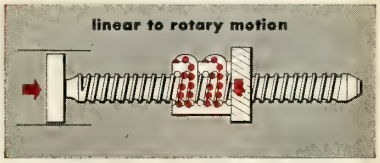
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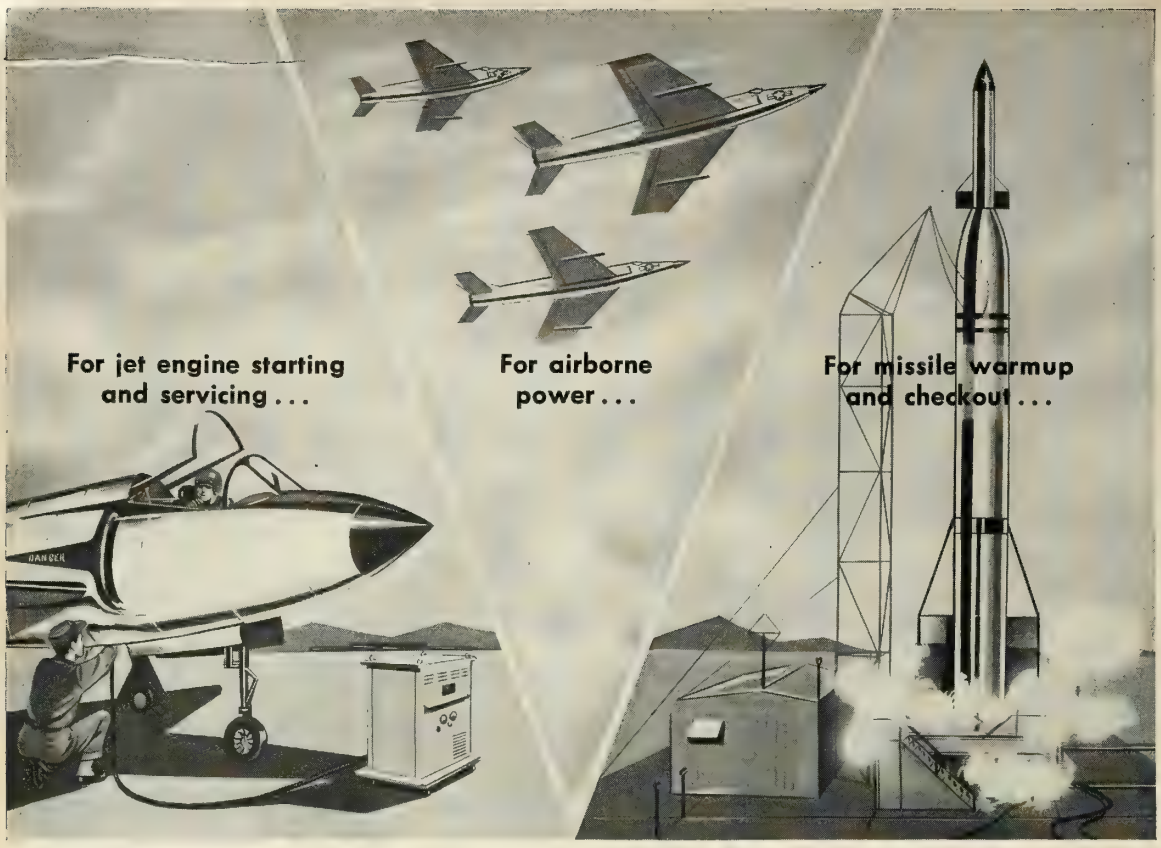
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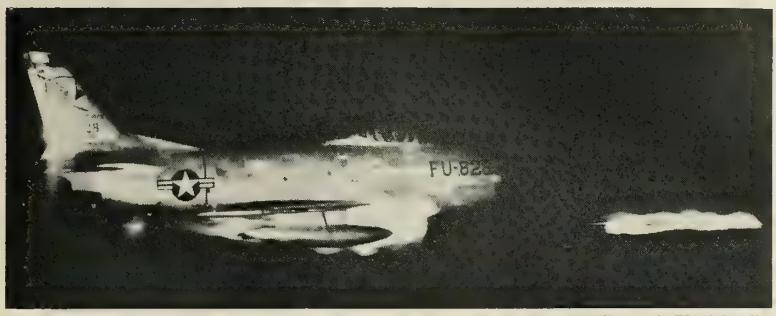
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PHOTOGRAPHING rockets at night requires split-second timing between pilot and photographer to insure usable results.

ternal missile use, designed to supply vital information on the launching and acceleration phase, missile component failure, and miscellaneous in-flight data to augment ground photographic tracking.

It is often desirable to study in-flight performance of experimental missile components or internal hardware that have become suspect on basis of past performance. Failure of such components is generally accompanied by peak vibrational build-up, which may progress for only a fraction of a second before total failure of the part under investigation.

Phenomena of such transistory nature can only be observed via ultra-high speed photography. Similarly, a running photographic record may be desired of internal missile instruments, particularly during launching and atmosphere re-entry.

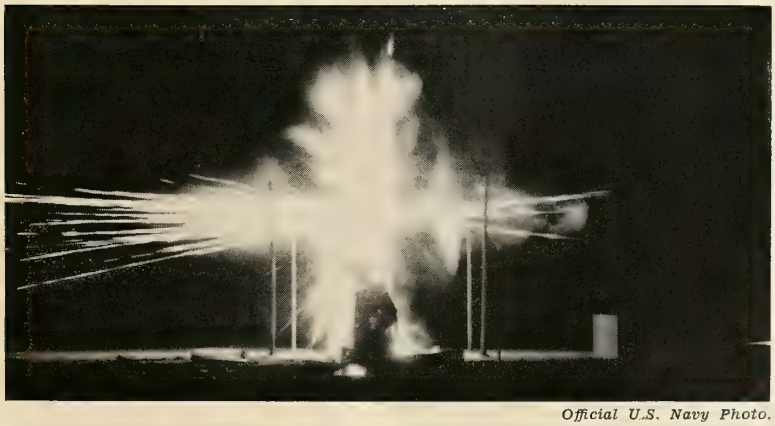
• **Missile photography essential**—According to the president of one major firm in the missile industry, photography provides an indispensable means for protecting the missile package—the thousands of man hours and often millions of dollars riding with a single experimental projectile.

Even if the missile fails to leave the launching pad, the state of missile art will advance with the helping hand of photography.

When it is realized that some companies carry a complement of 15 photographers to remote testing sites and send photo technicians as high as 40,000 feet in "chase" planes to document shakedown flights of prototype projectiles, photography appears to loom large in the future missiles picture.

Missile photography is yet a youngster and will presumably grow with man's strides into space. Currently, in the work-a-day world of missiles photography, test centers in conjunction with photographic manufacturers, are spearheading research into photographic materials to match the unusual testing conditions encountered.

Apropos is Khrushchev's recent comment to the effect that Americans have all the secrets of photography and Russians all the secrets of rockets, which contains at least a particle of truth—at least on the photographic side of the ledger.★



Official U.S. Navy Photo.

BLAST from an experimental warhead shows pattern in night photo.

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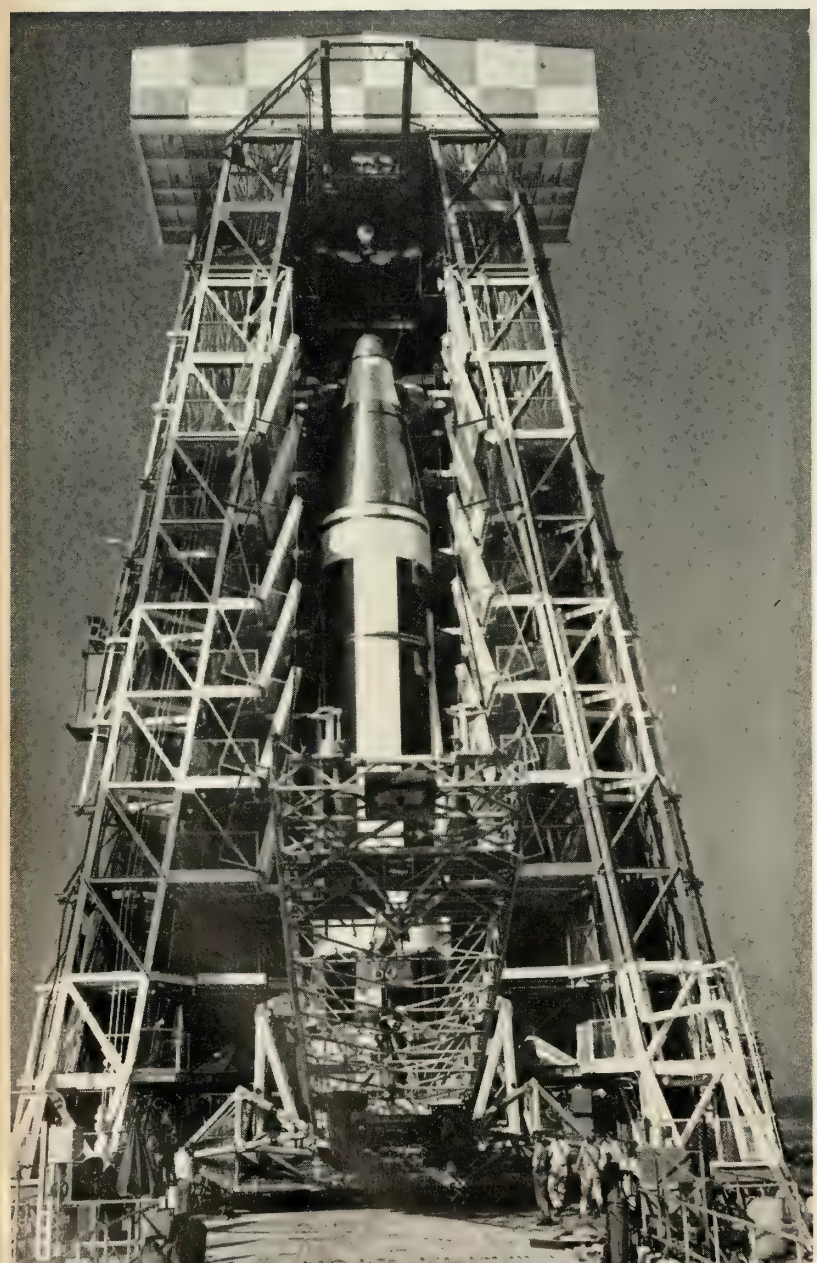
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Atlas Calls for New Shock Techniques

Mountings to withstand tremendous shock over relatively long periods developed for missile testing operations as new "birds" gain in power and speed



UNTIL FAIRLY RECENTLY, shock mounting systems were built to withstand relatively mild vibration and low-order shock over long periods of time. But, with the advent of missiles and rockets, came the need for mountings which could provide the utmost in reliability, during high launching shock and for upward of 30 minutes of flight duration, as the missile travels in and out of the atmosphere.

Scientific techniques and facilities solved this complex problem for the *Atlas* ICBM. These included the analog computer for optimum design, individual component tests to assure suitability, final tests on the completed assembly, and design refinements to provide the best performance.

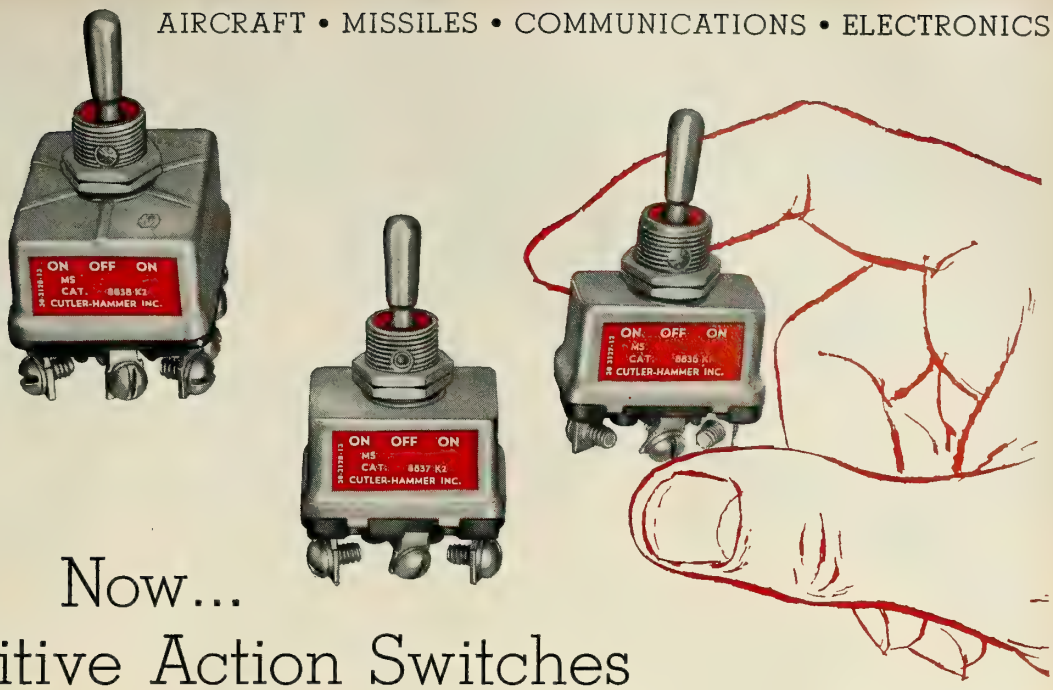
The problem of mounting sensitive electronic packages was encountered early in the *Atlas* development phase. The prime contractor, Convair Astronautics, required a complete mounting system, not just a simple vibration isolator.

This meant that the elastic, damping, snubbing and structural characteristics of the entire system had to be evaluated and a special mounting system designed. The vibration problems involved were so special that no stock mounting came close to meeting the requirements.

• **Rigorous specifications**—Convair established and met the following requirements for the performance of the mounting system:

1. The assembly (electronic equipment, mounting system and associated missile structure) would be subjected to a sinusoidal vibration of 1″ double amplitude displacement from 1 to 18 cps and ± 16 G from 18 to 2,000 cps along each of the three major axes, one of which must be the major longitudinal axis.

2. The assembly would also be



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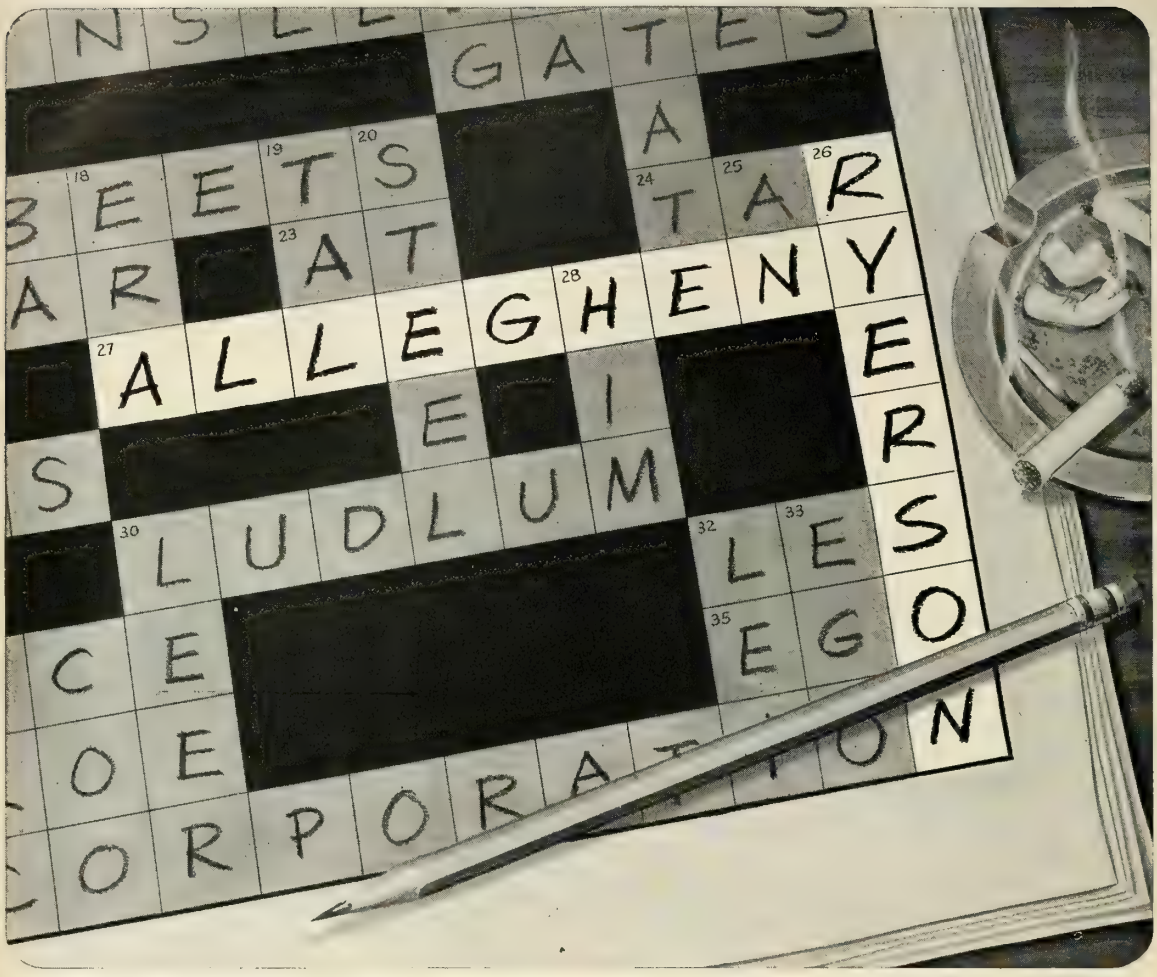
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subjected to the following steady-state accelerations which may be superimposed on the vibratory disturbances:

a) 10 G forward along the major longitudinal axis.

b) 2 G aft along the major longitudinal axis.

c) 1.5 G anywhere in plane perpendicular to the major longitudinal axis.

3. With any combination of the above vibratory and steady-state acceleration inputs to the assembly, vibratory response measured on the mounted electronic equipment must fall under a specific transmissibility curve. Any resonant peaks between 150 and 2,000 cps must be below a transmissibility ratio of 0.25.

4. In addition to the very difficult response requirements, the mounting system must withstand a 30-minute vibration dwell test along each of the three major axes, at the most severe resonant frequency for that axis, and at the specified input amplitude to the assembly.

5. The mounting system was required to have snubbing elements that would be operable only during excessive overloads, but yet not affect the operation of the mounting system during expected vibratory and steady-state accelerations. The mounting system was also required to be ultimately fail-safe with positive metal-to-metal interlocking parts.

6. The mounting system must withstand the following temperatures, under nonoperating conditions, without impairment of its capabilities: −80°F for periods of at least three days; 125°F, plus the full impact solar radiation of 360 BTUs per square foot per hour for periods of four hours per day, or 160°F with no solar radiation for periods of four hours per day, whichever is greater.

7. The mounting system must operate satisfactorily in ambient air temperatures of −65° to 125°F, and must withstand combined effects of any of the probable combinations of snow, sleet, hail, ice, fog, smoke, wind, sand, dust, ozone and salt atmosphere which might be encountered.

8. The system must be capable of both intermittent and continuous operation at relative humidities up to 100%, including condensation due to temperature changes. The system must fit a space envelope defined by Convair with a maximum motion in any direction of 3/8°.

9. Each of the cylindrical shaped electronic packages is symmetrical, and its center of gravity coincides with the elastic center of the mounting system.

• **Design analysis**—After thorough analysis, it was determined that the performance requirements could be best met with a vibration isolation system consisting of separate springs, damping elements and snubbers located symmetrically around each end of the electronic units.

Space limitations and the high performance specifications dictated that an optimum design be obtained. The analog computer was used to simulate all known system factors and evaluate the effects of a number of proposed design innovations.

Rapid solutions generated by the computer speeded the selection of a final system design. This was then fully evaluated over the entire frequency range, with the computer reproducing the exact performance conditions of the vibration isolating system.

The detailed design requirements of each of the separate elements of elastic restraint, damping and snubbing were separately considered and translated into manufacture of prototype components. Performance of both springs and dampers was then checked under the exact dynamic conditions that would be required by the design specification.

With the individual component designs established and with final dynamic component life tests completed, the individual components were combined with special supporting structure to complete the vibration isolator system.

The supporting structure for the vibration components was chosen to provide an extremely rigid structure to withstand high shock loads, and to be compatible with the stiff requirements of low transmissibility over the frequency range that runs from 150 to 2,000 cps.

• **Final system**—The final design of the canister-type mounting system supplied to Convair for use in the *Atlas* consists of two end rings that contain the vibration isolation components and two tie beams that hold the end rings in position.

The entire assembly fits on specially shaped cradle blocks, and is held rigidly in place by heavy steel straps that hold the end rings tightly against the mounting cradles. This arrangement allows the entire vibration isolator and electronic unit to be removed quickly from the supporting structure simply by loosening two bolts.

The sub-assembly at each end consists of an inner and outer ring connected by high-performance load springs, snubber assemblies, friction dampers and high-frequency surge suppressors.

The outer ring is of high-strength cast magnesium, with a special contour on the outside diameter to fit the supporting structure in the missile. The inner ring is machined to receive the mounting flange of the electronic package.

The complete assembly provides a compact high-performance vibration isolator which will protect the electronic equipment throughout the entire frequency spectrum. Special attention was given to the response of the complete system and associated structure over the entire frequency contemplated spectrum.

The required response over the entire frequency range was obtained by providing the desired structural frequencies in the mounting assembly, and the use of proper high-frequency design techniques.

This phase of the program was particularly important, since the effective input to the mounting components of the vibration isolator sometimes grows to 150 g in the high-frequency region, due to resonances in the attaching structure used in the missile. The final refinements during this phase of the design work were made by actual tests of the equipment on a high-frequency shake table.

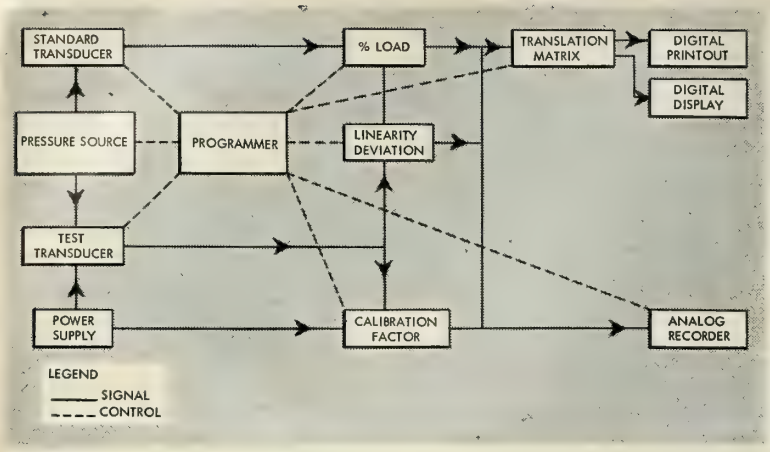
• **Stepped damping**—The extremely large amount of friction damping required to limit the resonant amplitude of the mounted equipment would have compromised the overall high-frequency performance. Stepped damping was introduced to improve the high-frequency response.

With a constant g input (a requirement of this mounting specification), the displacement amplitude decreases inversely as the square of the frequency. Stepped damping automatically provides a reduced amount of friction damping with decreasing input displacement, until all damping in the system is inactive.

At this point, the vibration isolator will respond as if it were a completely undamped system. This is the prime reason for the excellent high-frequency performance of the mounting system.

Recognition of unique problems such as those encountered in stock and vibration, and their solution by analytic methods, is a good indication that no approaches are being left unexplained in the design of the newest U.S. missiles.

The problem of shock and vibration is not a new one—it has long plagued automobile and airplane designers. Missile engineers must find answers faster.★



CIRCUITRY measures drift, zero-load output, temperature sensitivity and electrical calibration characteristics directly as a percentage of full scale.

New Aid to Testing:

Automatic Calibrator Speeds Missiles

by Donald E. Perry

WITH MANY PRIORITY missiles in advanced testing, pressure measurements of shock, acceleration and internal-external temperatures can not be more accurate than the calibration of the transducer itself. Thus there is an acute need for an automatic calibrator for missile work.

Such a calibrator has been developed by the Allegany Instrument Co. of Cumberland, Md. Known as the Autocal, the device eliminates three serious shortcomings of existing calibration techniques.

One is the time required. In many facilities where a large number of transducers are used in a single test, or where testing is done daily or weekly (such as static testing) a serious calibration backlog can develop.

A single transducer takes 10 to 15 minutes to calibrate. If electrical readout is not in immediately usable numbers, some 20 to 30 additional minutes will be required to rework the data. Often, high-priority missile tests must be held up, or if they go ahead, accuracy of data on pressure is questionable.

A second shortcoming of existing calibration techniques, generally not recognized in the missile industry, is the part that dynamic characteristics of pressure transducers are different than characteristics revealed by present static calibration techniques.

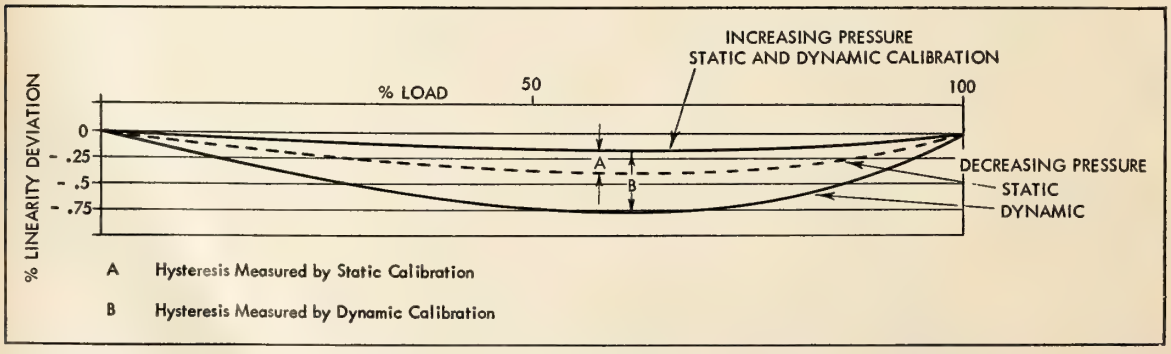
A third point is that calibration accuracy is limited by calibration equipment, and much equipment today has been adapted or converted from the basic design function for which it was built.

• **Advantages**—Allegany's Autocal promises to overcome these problems. Autocal calibrates one to twelve pressure transducers at an average of two minutes per transducer, which could eliminate calibration backlogs. No time is lost connecting and disconnecting transducers.

A transducer can be replaced as soon as it is calibrated, without interrupting further calibration. This makes it possible to calibrate over 200 transducers a day with one or two operators, and saves considerable costs at test facilities.

Autocal also displays and records linearity, hysteresis, calibration factor and drift characteristics. It is upon these determinations that the accuracy of the pressure measurement depends.

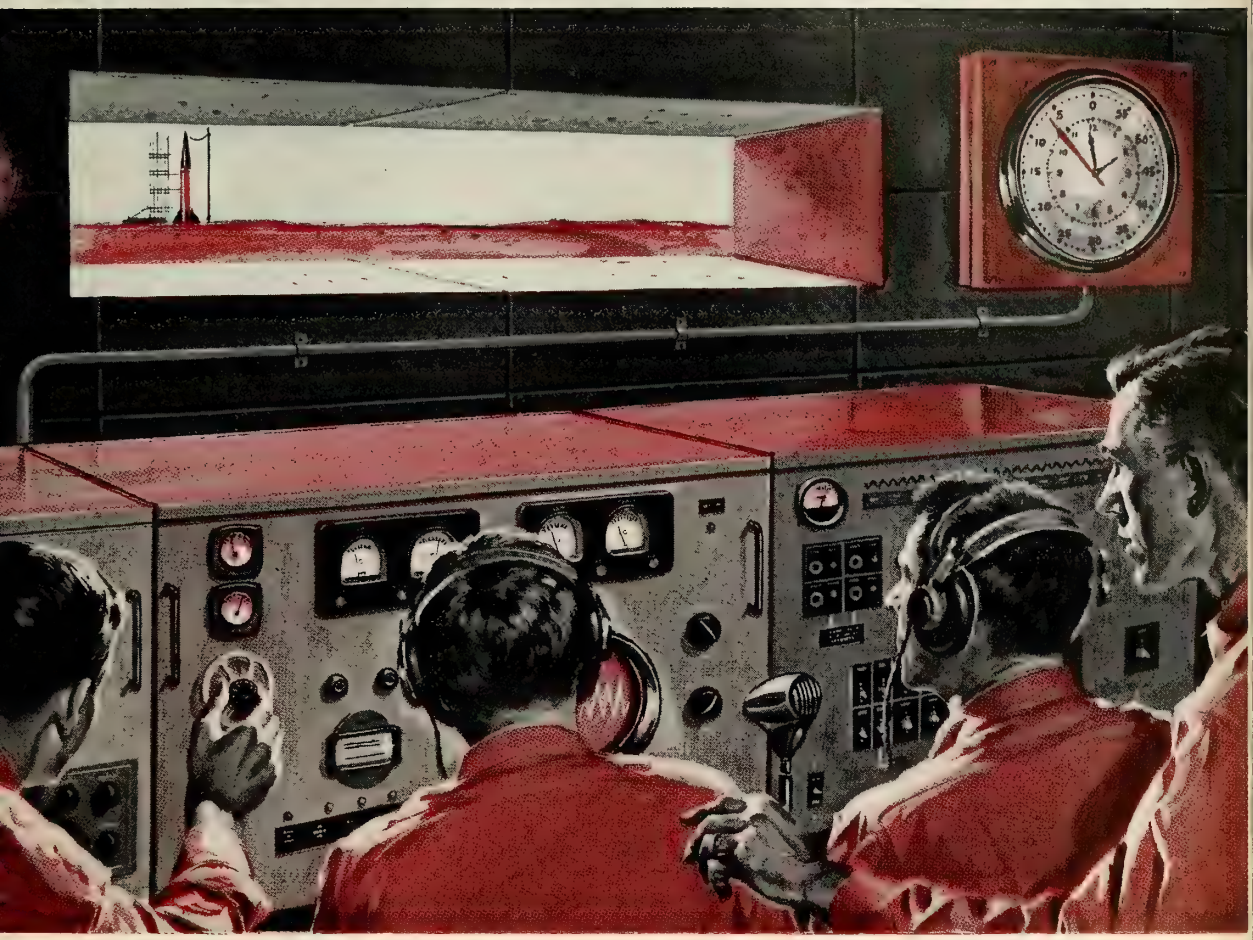
The device is not an automation of



DISCREPANCIES between the step function and Autocal's continuous-type calibration were realized by calibrating a number of pressure transducers both ways. Linearity deviation differs from 0.5% to 1.0% of full scale. Note average discrepancy.

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Link can be of assistance in solving your problem. Write or call Jack Ritchie, Engineering Sales, Binghamton 3-6311 (ext. 277) for complete information. A brochure of our facilities is available on request.

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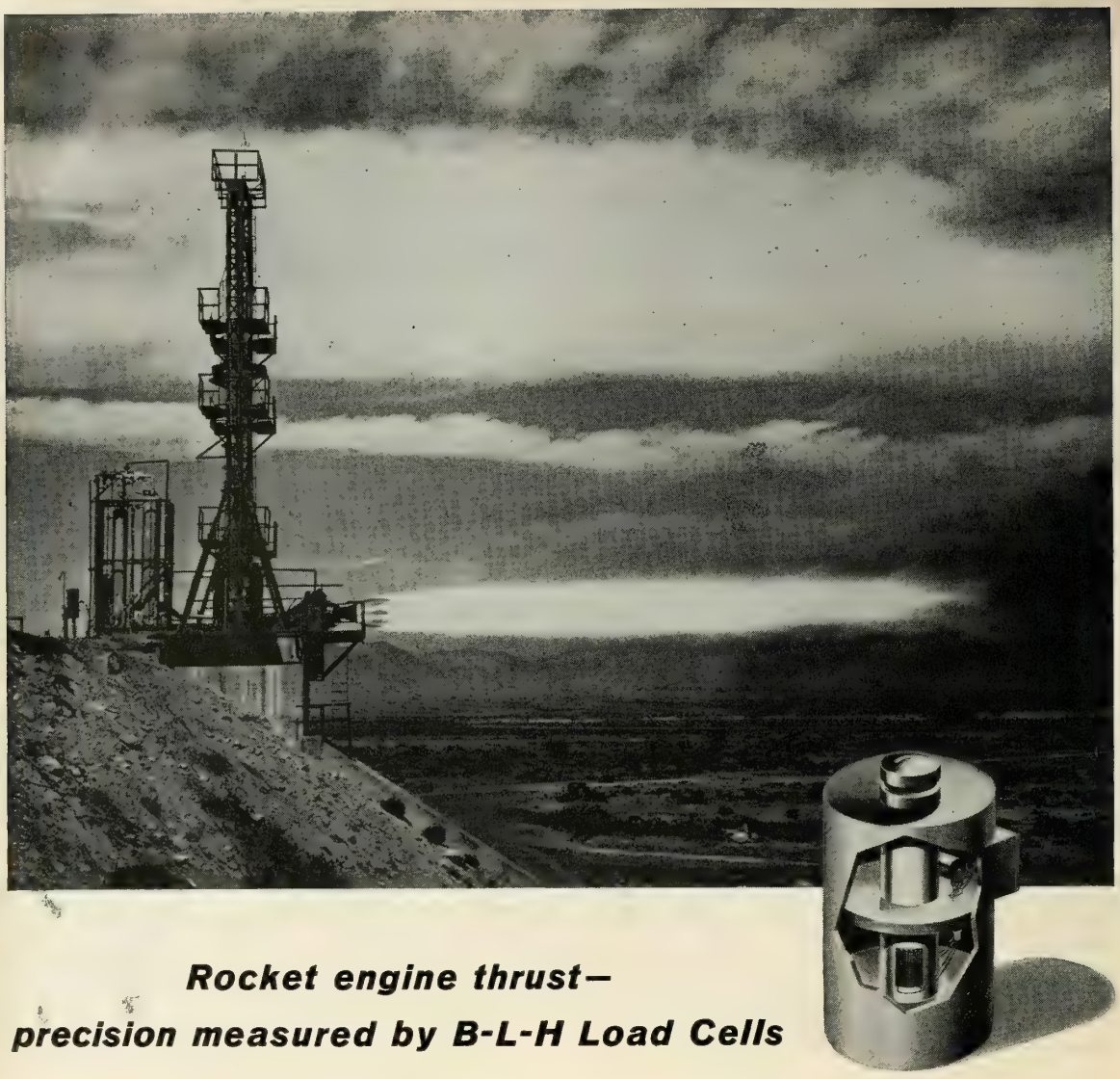
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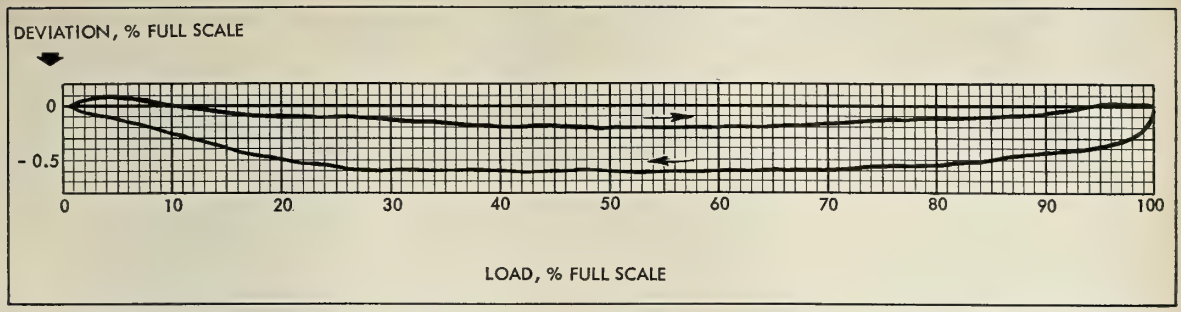
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X-Y RECORDER of Autocal provides continuous record. The recorder is electrically driven through a mechanical take-off from the servo balancing motor shaft. Consequently, the accuracy of the digital information is not affected by any possible inaccuracies of the X-Y Recorder. Records produced increased calibration efficiency.

present step-function calibration principles with digital voltmeter readout. It does, however, employ the principle of dynamic calibration with digital readout in transducer terminology.

• **Factors to watch**—The step-function techniques with static readout, in which pressure is applied in steps, has inherent faults that affect transducer calibration accuracy. These faults include pressure overshoot, drift due to waiting for equilibrium and "hunting" due to pressure leakage.

Under the "step" method, pressure is rapidly applied until a desired value is reached. Then, after waiting for equilibrium to be reached at that value of pressure, a reading is taken. This usually requires four steps, with the equilibrium point at each step determined by floating a dead weight or starting a pressure regulator.

This method is satisfactory for calibation of visual gages, and for manual calibration of pressure transducers when proper precautions are taken in applying pressure.

But there are factors which influence calibration accuracy. For example, pressure overshoot (due to the inertia of a compressible pressure medium) exercises the transducer about the calibration point and does not give a true reading for that point.

As a result the data point cannot be taken immediately and sufficient time must be allowed to reach equilibrium. Waiting for equilibrium, transducer output will drift because of redistribution of stresses in the sensing element, and the apparent characteristic will be influenced by the time required to take a data point.

Calibration can be further affected by "hunting" due to pressure leakage and necessary correction. Leakage may occur at pressure connections and between the dead weight piston and cylinder.

This leakage is an important consideration in a multi-channel calibration system where many pressure connections are used. Each connection increases possibility of leakage, and a steady equilibrium point in reality can never be reached.

• **Function of system**—To overcome the accuracy limitations of step-function and static readout technique, Autocal has a dynamic pressure calibration system. This technique features a continuous pressure curve that increases linearily from zero to full-scale pressure, and then back to zero pressure. Most important, data is taken at any desired point along this curve.

With a continuous pressure curve, errors present in static calibration are eliminated, and since the pressure function is continuous, overshoot is not possible. Transducer drift is also eliminated because it is not necessary to wait for a reading.

The system is in continuous equilibrium and data can be obtained at any time. "Hunting" due to pressure leakage is eliminated for the same reasons.

To determine quantitatively the discrepancies between the step-function and Autocal's continuous-type calibration, a number of pressure transducers were calibrated both ways. Linearity deviation was found to differ from 0.5% to 1.0% of full-scale pressure.

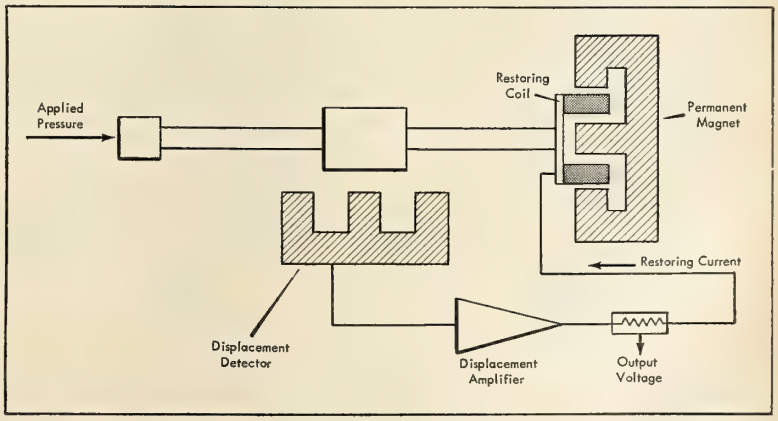
The actual Autocal circuitry was designed to measure cracacteristics such as drift, zero-load output, temperature sensitivity, and electrical calibration directly as a percentage of full scale. Desired accuracy for measuring charactertistics often is 0.1% full scale or better.

To obtain this accuracy, measuring circuits should have a resolution of approximately 0.01% full scale. This requirement plus the low voltage output of wire strain transducers, led to a potentiometer circuit using a null balance principle as the method of obtaining the desired resolution and accuracy.

• **Measuring pressure**—A standard transducer of the force-balance type is used to measure the applied pressure. An all-electronic servo system applies a feed-back current to the standard transducers that is proportional to the applied pressure.

The linearity and hysteris is of the standard transducer is less than .05% of full scale, and can be considered to be a straight line in this application.

The output of the standard transducer is read by the percent load cir-



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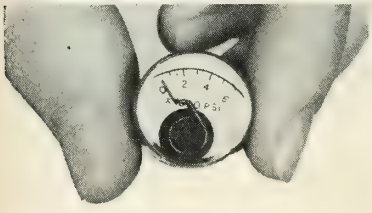
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cuit with a full scale reading of 100% for any pressure range. The pressure at any intermediate point is read directly, therefore, as a percentage of full scale.

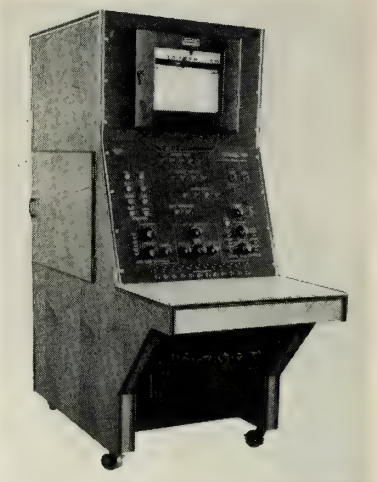
The linearity deviation of the test transducer is determined in one measurement and expressed directly as percent of full scale. This is accomplished by accurately comparing the outputs of the tests and standard transducers.

Because the standard transducer is linear, test transducer linearity appears as error signal and is measured in the deviation circuit. This permits higher accuracies than possible by measuring the actual voltage output of the test transducer and then determining the deviation from a straight line.

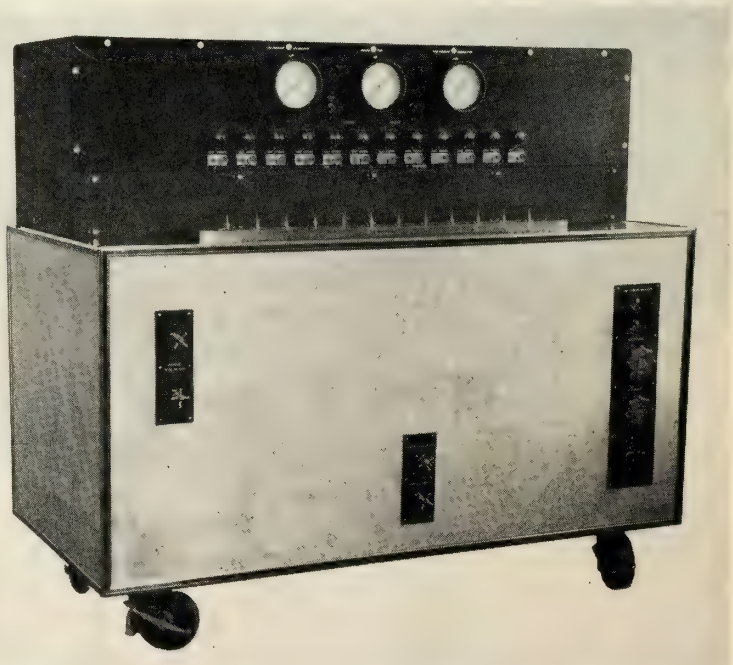
Similarly, the Calibration Factor Circuit determines test transducer full scale sensitivity in a direct measurement. This circuit measures the ration of the test transducer full scale output to its excitation voltage or current, in order to obtain the mv/v or mv/ma factor, and eliminates absolute measurements of output and excitation. Accuracy is thus improved by a factor of two or more.

A servo-operated circuit is provided to balance the test transducers to zero electrical signal at zero pressure. Because the conventional shunt balancing circuit can effect the transducer sensitivity and cause a calibration error, a voltage bucking circuit has been selected and introduced to balance the test transducer.

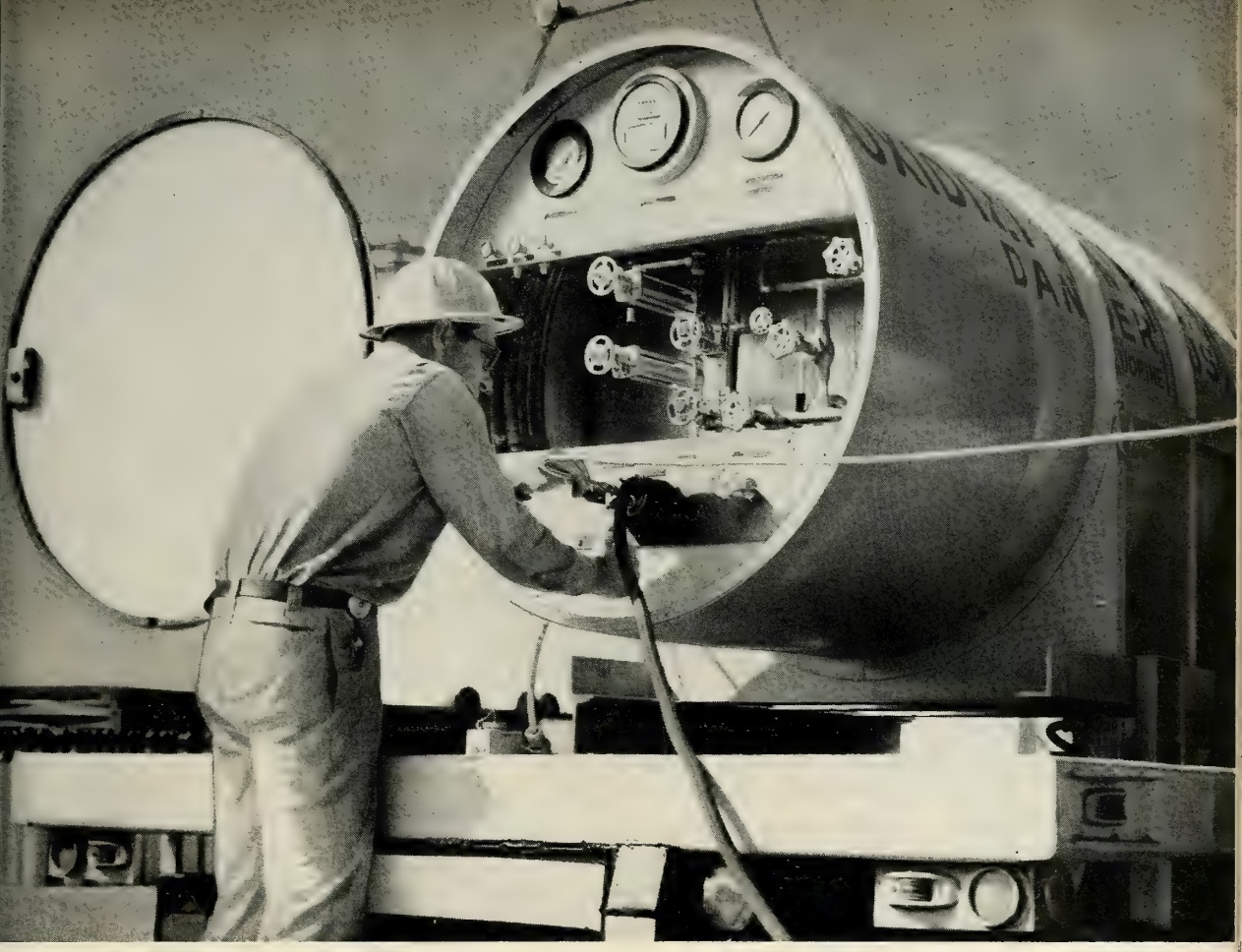
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- Electronic console and rack coolers (bulletin 105)
- Small portable field units to cool huts filled with electronic gear for missile ground support, battlefield television, communications and radar (bulletin 106)
- Conditioning systems for Radome shelters (bulletin 108)
- Mobile cooling units for trailer-mounted electronic systems for missile and aircraft ground support (bulletin 111)
- Units to cool automatic landing devices for carrier and land-based aircraft (bulletin 122)
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- Dewpoint control equipment for pressurized radar waveguides (bulletin 128)

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ELLIS AND WATTS PRODUCTS, INC.

Cincinnati 36, Ohio.
Designers and builders of MIL-AC Units

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the measured transducer characteristics. These are digitized by shaft position encoders, and an output is provided for an IBM summary punch.

Although digital readout gives higher accuracy and resolution than analog recording, it is a sampling system and does not provide a continuous record. An X-Y Recorder is incorporated to provide this information.

The recorder is electrically driven through a mechanical take-off from the servo balancing motor shaft. Consequently, the accuracy of the digital information is not affected by the inaccuracies of the X-Y Recorder.

• **Physical description**—Autocal has two semi-portable cabinets interconnected by three electrical cables. The pressure cabinet contains six standard transducers, a standard transducer selector and servo system, manifold connects for 12 test transducers, test transducer excitation voltage power supplies and of course, pressure manifold.

Also featured is a pressure and vacuum source with linearizing valves, rate valves, by-pass valves, pressure regulators, and other components necessary for operation.

The pressure cabinet is controlled electrically by the electrical cabinet. Six standard transducer mounting positions are in the pressure cabinet, any one of which is selected by a switch in the electrical cabinet. A standard transducer can be quickly mounted in any position to cover more than six pressure ranges.

The electrical cabinet contains the control panel, control circuits, measuring circuitry, analog-to-digital converters and translation matrixes, X-Y Recorder, and other components required for measuring transducer characteristics and controlling calibration cycle.

Digital information is displayed on the control panel lamp banks on a cyclic basis. Printout is made by command from the control circuit and overrides the cycling system. After printout, the cycling system again resumes control of the displayed information.

Information also is recorded in log form on an X-Y Recorder. A pen indicates the present load, while the chart position indicates the percent linearity deviation. In this manner, a deviation vs. load curve is drawn as pressure is applied to the transducer. A second pen is used to record the calibration factor.★



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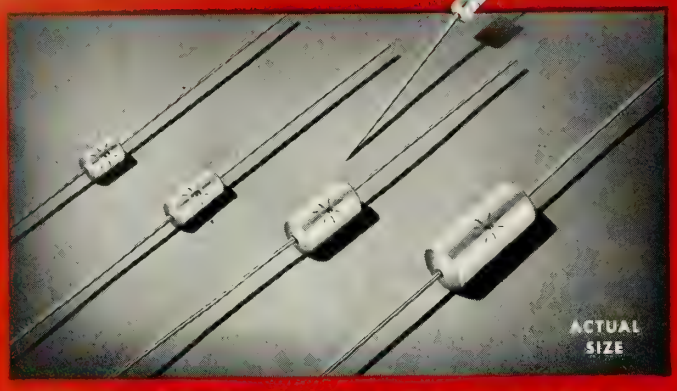
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	STA-172	1.2	30	36
	STA-177	1.0	35	42
400 SERIES	STA-437	7	10	12
	STA-462	4	15	18
	STA-467	3	20	24
	STA-472	2.4	30	36
	STA-477	2	35	42
200 SERIES	STA-257	17	10	12
	STA-262	11	15	18
	STA-267	8	20	24
	STA-272	6	30	36
	STA-277	5	35	42
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Moscow briefs

• **Re-entry problems**—The problem of returning future *Sputniks* to Earth intact is summarized in SOVETSKAYA AVIATSIA by V. Borisov, of the Astronautics Section of the Shkalov Central Aeroclub in Moscow.

1. Deceleration of the *Sputnik* must be achieved gradually.

2. The Earth's atmosphere can be utilized in such a way that, on the *Sputnik's* return, the satellite will re-enter the atmosphere in a spiral. This can be accomplished "by changing the *Sputnik's* structure and its ascending power."

3. Most important, "all methods of returning the *Sputnik* to Earth boil down in the final analysis to a fight against high temperatures," the Soviet scientist explained.

Deceleration, Borisov explains, can be accomplished, among other methods, by magnetic aerodynamics. Magnetic fields will help solve the problem of safe re-entry for satellites in the following way:

As friction and burning of the *Sputnik's* shell ionizes the air in front of the moving satellite, the area surrounding the *Sputnik* becomes a conductor of electricity. This particular conductivity can be increased near the moving *Sputnik* by scattering small quantities of elements possessing a high ionization capacity, such as sodium and potassium.

The hot air, containing ionizing elements, will play the role of coils of the armature of an electric-current generator, while the magnetic field created by the *Sputnik* will be the generator's constant or direct field.

As the *Sputnik* reenters the atmosphere, the passing of such armature from the hot air through the *Sputnik's* magnetic field will create an electric current, thus decelerating the air's rush against the satellite.

This electrical current will sharply reduce the temperature of the *Sputnik's* surface, the Soviet article stated.

Various other systems of cooling and protecting the *Sputniks* are mentioned by Borisov, including "a ceramic surfacing, containing 20 kilograms of oxide of beryllium, which can absorb the heat exuded during a vertical 40-second fall of a *Sputnik* weighing 45 kilograms."

Cooling systems listed by Borisov include circulating methods, porous methods, and evaporating methods. The circulating cooling system depends on a gas or liquid sent through the *Sputnik's* heated parts "to turn the heat away."

The porous method is based on a liquid which gradually comes through

. . . moscow briefs

special pores in the *Sputnik's* shell, evaporating at the expense of aerodynamic heat, and "thus saving the shell." Cooling is achieved from evaporation when "the upper stratum of the shell evaporates by changing from a solid into a gaseous state."

• **A large** *Sputnik* will serve, within a few years, as an assembling and launching site for space rockets, predicts Prof. E. Kollman of Moscow. He declares that among the rockets to be launched from *Sputnik,* the first rocket will orbit the moon and check "the effect of flight on a living organism." Other rockets will be launched from *Sputnik* to land on the moon without crews in their initial phase, and later with crews. Finally, the *Sputnik's* personnel will hurl rockets up to Mars.

• **Soviet rockets**—"There is no doubt whatever," writes Y. Golovanov in KOMSOMOLSKAYA PRAVDA, "that in the next few years our brain, will power, and toil will prove to be stronger than the Earth's gravity, and . . . above the Moon's gigantic craters our Soviet rocket will rush, filling the hearts of Earth's people with pride and joy."

Golovanov also said about the future use of rockets in transporting Soviet freight and mail, "Inhabitants of Vladivostok will receive Moscow newspapers only 40 minutes after the papers come off the press."

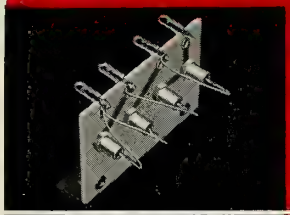
• **At the recent national congress** of the Communist Youth League in Moscow, the League's secretary charged that, "although Soviet people have accomplished veritable miracles in science and technology, Soviet writers have failed to create artistically outstanding books about these wonderful achievements."

In KOMSOMOLSKAYA PRAVDA, foremost Soviet writers and editors specializing in the popularization of science published a collective letter complaining that their field is woefully neglected by young Russian journalists. Only a little more than 100 Soviet writers and journalists chose science and technology as their regular subjects, and among them new writers are rare.

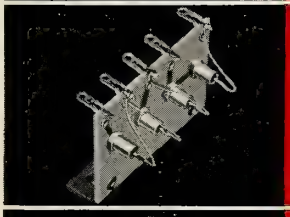
The authors of the letter appealed to the Soviet government to increase the number of science writers and to establish a central organization for them; above all, to introduce a regular program of training for young writers aspiring to be experts in the scientific-technological field.

• **Plastic rockets** are a sure thing of the future. So predicts V. Korshak, a

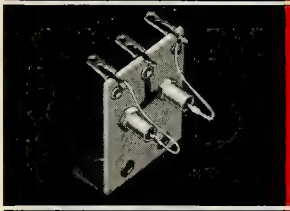
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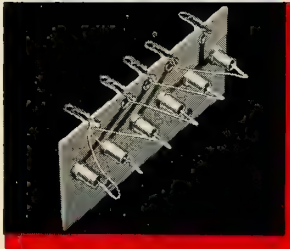
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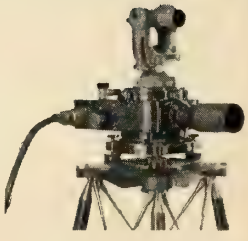
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corresponding member of the Soviet Academy of Sciences. He declared that in time not only airplanes, but rockets, will successfully be built of plastics.

• **Tantalum, one of the rare metals** known for its extreme heat-resisting quality and used in rocket and jetplane-construction, is a special feature of the Soviet Scientific-Research Institute of Colored Metals and its Rare Metal Laboratory, located at Ust-Kamenogorsk in Soviet Kazakhstan. (This, incidentally, is the town where former Premier Georgi Malenkov is now the exiled manager of a local power station.)

A recent Soviet report states that the Rare Metal Laboratory is regularly visited by the metallurgical experimenters of China, Bulgaria, Rumania, Poland, and other Red-bloc countries. They use the Laboratory in their atomage work with rare metals.

• **The moon's crust temperature** will soon be measured by Russian scientists with the aid of a new and special telescope. This telescope, says TRUD, "will allow scientists to measure in millimetric waves the temperature of the uppermost stratum of the Moon's crust, at the depth of about a centimere."

• **The American command** "has no effective means to combat guided ballistic rockets," writes Col. B. Aleksandrov in SOVETSKAYA AVIATSIA. These rockets are presumably those to be launched by Soviet forces in case of war.

• **A cruiser rocket-carrier** is apparently a part of the Soviet navy, judging from a statement buried in a recent TRUD article.

• **The Russian ICBM** "showed the world's record of speed and distance and thus opened new horizons in science," declared President Alexander N. Nesmeyanov of the Soviet Academy of Sciences. The recent annual meeting of the Academy was devoted to a review of 1957 achievements.

• **The Academy's astrophysical expedition,** headed by Professor V. G. Fesenkov, has returned to Moscow from Egypt where it completed its investigations of zodiacal light in the Nubian desert. Egyptian scientists participated in the work of the Soviet group. Political, as well as scientific considerations, motivated the sending of this Soviet expedition to the Middle East. Similar researches were simultaneously conducted by other Russian astrophysicists in Soviet Central Asia.

• **In the Soviet pavilion** at the Brussels Fair, the full-scale models of *Sputniks* I and II continue to attract general attention. The model of *Sputnik* I is suspended in air, while that of *Sputnik* II is on a revolving stand. The famous beep-beep sounds are reproduced faithfully.

Considerable interest is also aroused by an exhibit called "Cosmic Rays." Created by a group of Soviet scientists, it illustrates the inception and development of a cosmic-ray shower. The exhibit demonstrates a process wherein a cosmic ray strikes the atoms of an air stratum, breaking and splintering these atoms as they reach the Earth in the guise of secondary rays.

The entire process is shown with the aid of multicolored electric lamps attached to clustered metalic rods. Also exhibited is a powerful apparatus, claimed to be of original Soviet construction, showing cosmic particles as they actually penetrate the exhibition hall from cosmic space.

• **Three Soviet organizations** will open a "world center" of IGY data in Moscow. The center will be a special building in the Lenin Hills, presumably near the famed skyscraper of the University of Moscow. It will have its own libraries, laboratories, and other facilities.

The three sponsoring organizations in charge of IGY work by Russian scientists are:

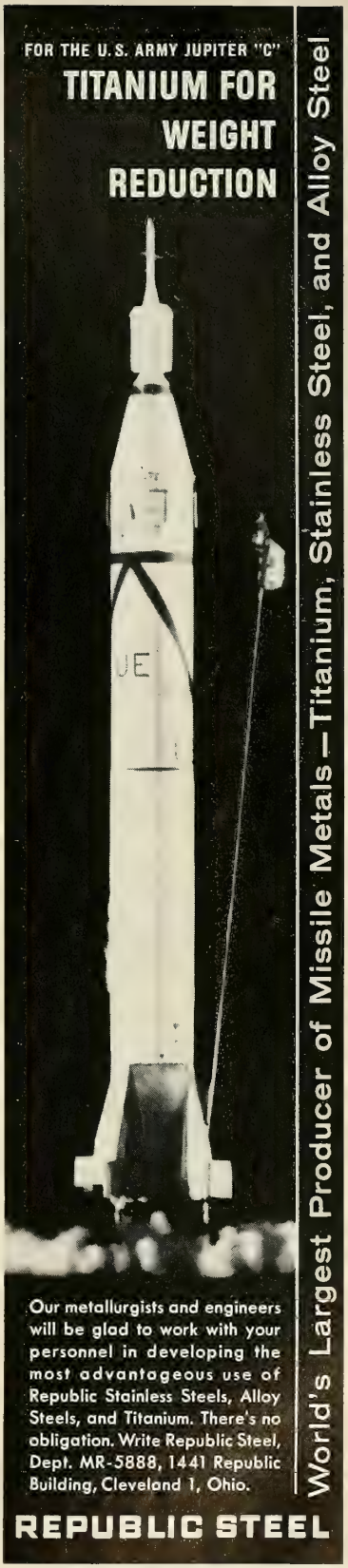
The Scientific-Research Institute of Aeroclimatology, also known as the Chief Office of the Hydrometeorological Service, attached to the Council of Ministers; the Scientific-Research Institute of Earth Magnetism, Ionosphere, and Radiowave Distribution, attached to the Ministry of Communications; and the Academy of Sciences.

The "world center" of Soviet IGY data will be open to both Russian and foreign scientists, who will be free to acquaint themselves with the center's materials and research facilities.

• **Red kudos**—The Soviets have praised the astronomical observatories of Chile, Finland, the Netherlands, China, Czechoslovakia, Bulgaria, Poland, and Yugoslavia for being especially helpful in relaying to Moscow their observation data on *Sputnik* II.

• **Stargazing**—Main center for meteorite-filming for the Soviet IGY program is the University of Odessa's astronomical observatory. Moscow Izvestia recently devoted a special feature article to its "meteorite patrol."

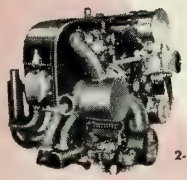
• **French missiles**—The Soviet ministry of defense has evidenced interest in the testing field of the French army's



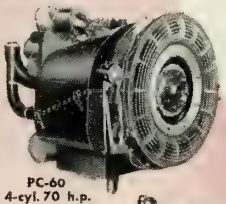
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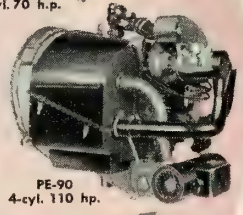




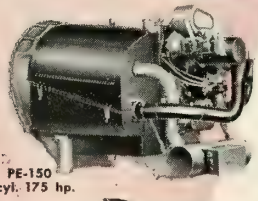
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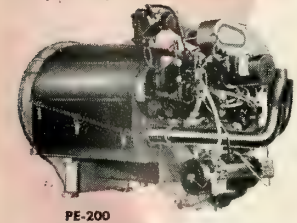
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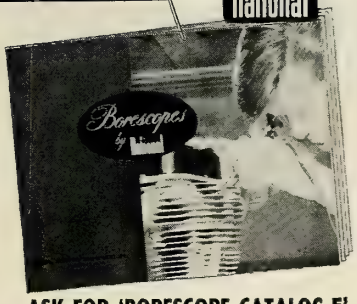
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guided missiles in the Sahara. A detailed article on this subject recently appeared in the ministry organ, KRASNAYA ZVEZDA. The author, G. Polskoy, writes that "only fragmentary information is available" about this 10-year old field, but that nevertheless "this information permits us to form some idea about the French firing ground in the Sahara."

• **Coming attraction**—Late this spring or early in the summer, British leftists plan a "march of protest" against American rocket bases on British soil. The march will begin in the extreme south of England and will terminate at that point of northeastern Scotland where one of the rocket bases is to be established. The Soviet press applauds the planners of the protest demonstration.

• **Capitalistic Recognition?**—OGONIOK revealed recently that Konstantin Tsiolkovsky (1857-1935), Russia's famed rocket pioneer, was granted patents not only from the Russian government, but also from Washington, Vienna, Paris, Berlin, Rome, London, Brussels and Stockholm. A recent exhibit of the original patents at Moscow's Polytechnical Museum attracted many visitors.

• **Red missile base**—Informed sources indicate that Russia may be building missile launching sites in Valona, Albania, an Adriatic port about 400 miles from Rome.

This information follows reports that Russian missile bases are also being established in four other Red satellites—East Germany, Poland, Hungary and Czechoslovakia.

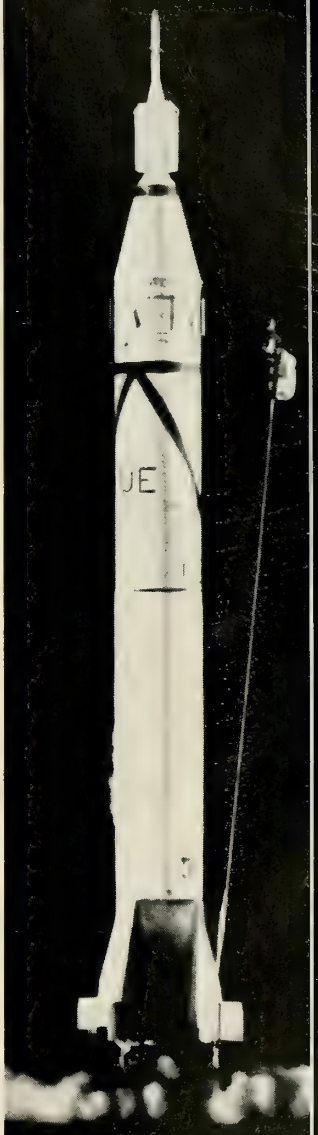
The information did not spell out the type of construction, but it was speculated that a missile launching base was being built within easy striking distance of such Western allies as Italy, France and Greece, and all of Western Europe.

• **Rocket to the Moon**—A European news agency recently reported that Russia had attempted to launch a rocket to the Moon, but the effort failed when the first stage of the rocket exploded. The launching was reported to have occurred at a super-secret missile base in Siberia known as "Sputnikgrad."

According to the news dispatch, the explosion caused considerable damage, but no casualties. The experiment was reported to have failed because of a chemical fuel explosion in the first stage of the rocket.★

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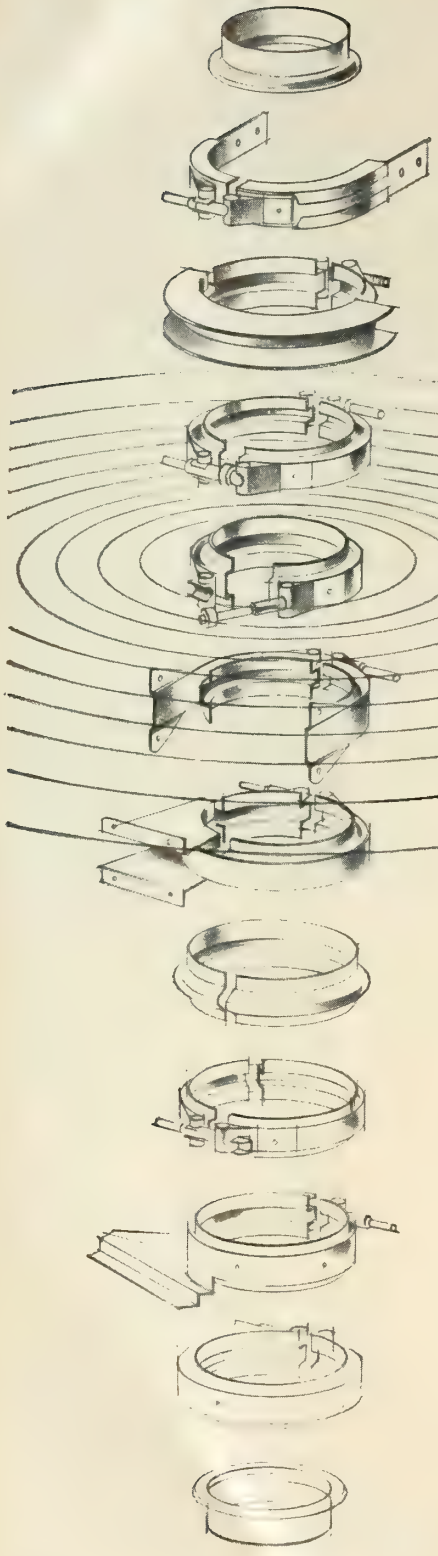


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soviet affairs

by Dr. Albert Parry

So many inquiries have reached me on Moscow's experiments of using artificial ball lightning as a missile (the topic of my April column), that I am adding additional comments on this subject.

One comment, made to me by an American physicist, is that artificial lightning can indeed be created in an enclosed area, not only as Dr. George Babat and other Soviet experts have apparently done, but also as our General Electric experimenters achieved with resulting tremendous temperatures and power.

But, to obtain any such high power in open spaces, and to aim it successfully at definite targets as a missile, is quite another feat, and in the physicist's view, impossible.

My answer to this is—I am not saying that it is either possible or impossible. My intention is merely to report what the Russians are saying about their experiments, both officially and unofficially.

Dr. Babat stated in KOMSOMOLSKAYA PRAVDA (since my April column) that "mysterious ball lightning is a lump of high-temperature plasma, held in the state of a short-term balance by electromagnetic forces." He confirms that he began his experiments in 1940 by working with "non-electrode discharges" wherein he used high-frequency transformers, with armature "made not of wire, but of a ring of ionized gas."

Into this ring of plasma, freely floating ("like a ring of smoke sent up by an experienced tobacco smoker"), electric currents were introduced, and "under certain conditions, our ring of ionized gas was tightened into a fiery lump similar to ball lightning.

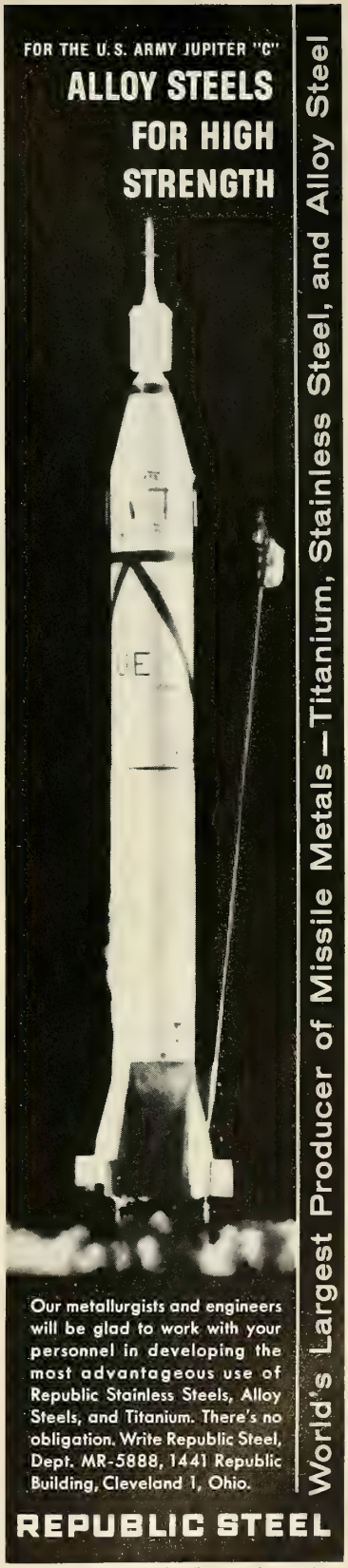
Dr. Babat's early experiments are connected with the later work of Professor Igor Kurchatov who, in the spring of 1956, spoke of the Soviet data obtained by discharging powerful electric currents through gaseous heavy hydrogen. The fiery "cord" of ionized gas or plasma, formed by these discharges, had reached temperatures of nearly one million degrees.

A short time ago, the Zeta installation at Britain's Harwell Atomic Research Center produced non-electrode plasma of temperatures up to five million degrees.

However, the Soviets do not lag far behind. On April 22, 1958, a Lenin Prize was awarded to a group of Russian physicists, headed by Academician L. A. Artsimovich, for successful researches in "powerful impulsive discharges in gas to obtain high-temperature plasma."

To harness thermonuclear power is of course the chief aim of all such experiments, Soviet or Western. In his latest statement, Dr. Babat promises that next September, at the Second Inernational Conference on Peaceful Uses of Atomic Energy, "Soviet scientists will tell about their new work" on thermonuclear reactions in connection with ionized gas or plasma.

We may then learn more about Dr. Babat's experiments with artificial ball lightning as one form of such plasma.



Circle No. 11 on Subscriber Service Card.

MISSILE ENGINEERING

The "collapsing of time" concept has taken on added significance as a result of the current international situation. In Tucson, Arizona, Hughes has established the Tucson Engineering Laboratory for the purpose of shortening the elapsed time between missile development and its effective tactical use. This activity, established over 2 years ago, has proven that the quasi-simultaneous development and production of missiles can become a feasible reality.

The Tucson Engineering Laboratory is now expanding its scope of operations. Mechanical Engineers, Electrical Engineers, or Physicists who like to work on urgent problems and who have the ability and enthusiasm to constantly improve the product and its reliability, will find this an ideal environment. Specific areas of interest include: missile system analysis, infrared and radar guidance systems, electromechanical and hydraulic control systems, missile and test equipment and electronic circuit design.

An added advantage: Tucson's dry healthful climate. Investigate by sending resume to Mr. W. A. Barnes at:

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HUGHES

TUCSON ENGINEERING LABORATORIES

Hughes Aircraft Company

Tucson, Arizona



propulsion engineering

by Alfred J. Zaehringer

Propellant polarograph identifies rocket fuels at NOTS. The electrical method does not destroy the sample, requires only small amounts, and is accurate down to trace amounts measured in parts per million. Qualitative and quantitative results are rapidly given.

Chemical "kites" may use high altitude free radicals. Work done at Aerojet indicates that at about 60 miles altitude, there is enough atomic oxygen to give a heat release of 10^{-6} calories per cc of air. A chemical "kite" (ramjet), with a catalyst to effect oxygen recombination to molecules, might give a thrust of about 40 dynes per square centimeter of ramjet inlet area. The thrust of such a ramjet would be independent of the vehicle flight speed, but the low thrust would mean very light kite-like structures.

Boron "exotics" may remain specialty fuels. Cost will probably never run below $10 per gallon. Biggest use will be for modified turbojet engines (afterburners), ramjets (high altitude), or for high-performance liquid rockets.

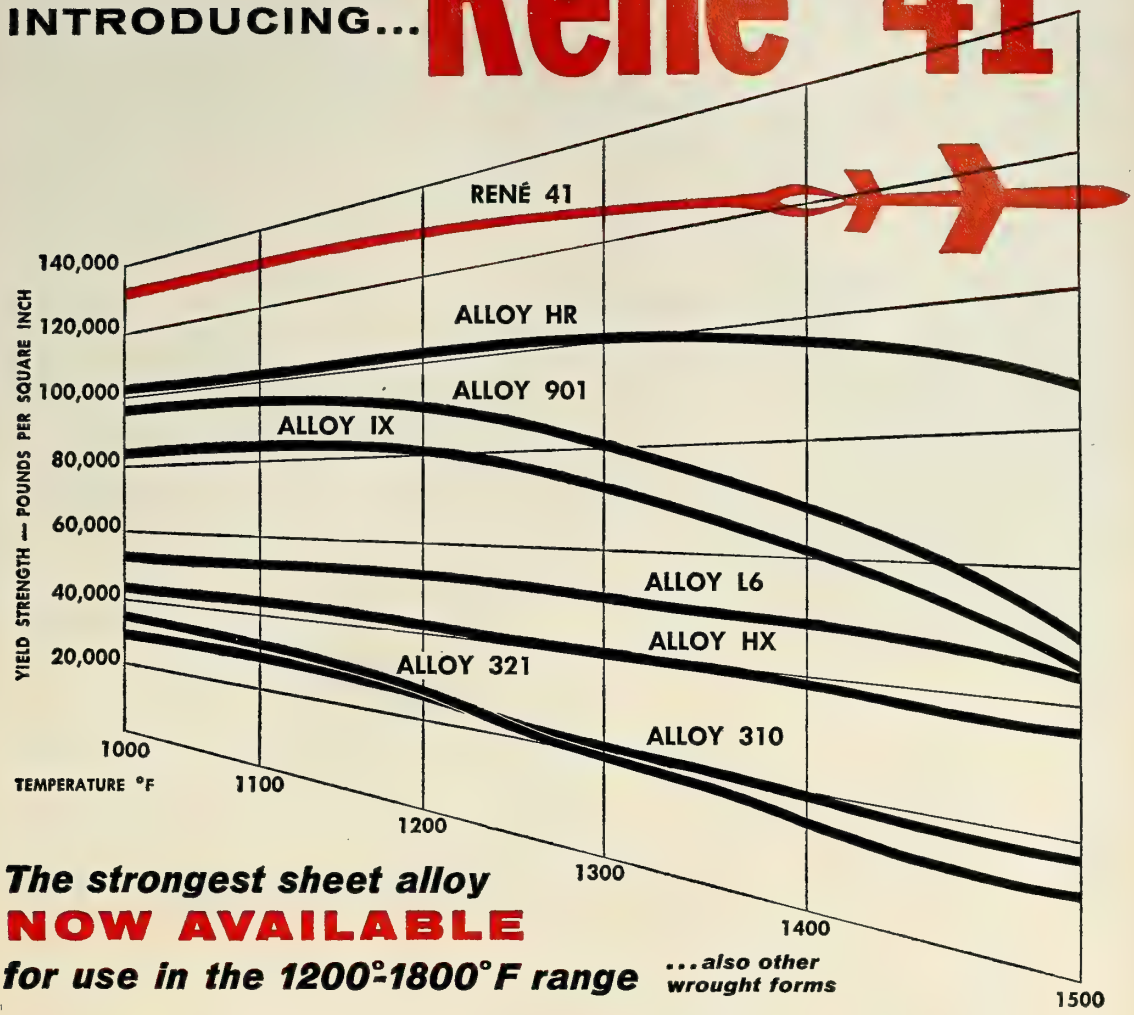
Big boron boom is now going on to adapt these fuels for solid-propellant use. First solid-propellant use will be as a solid additive to present organic fuel-binders. Next step will be to use a liquid boron hydride which can be polymerized to form a solid fuel-binder. Toxicity, reactivity, and aging characteristics in solids may prove to be formidable stumbling blocks in solids. These dangers, however, may be less critical than for liquid propellants.

What are the hottest-burning metals? Sponsored research at Temple University's Research Institute reveals that there are only four metals that have adiabatic combustion temperatures (at one atmosphere pressure in oxygen) of over 4,000°K. These are: beryllium, 4,300°K; thorium, 4,700°K; hafnium, 4,800°K; and zirconium, 4,800°K. Under the same conditions, aluminum flame is 3,800°K (4,400°K at 10 atm.).

Solids are expanding out West. Shell Development Co. at Emeryville, Calif. has been doing classified work on solids. This could involve Shell's "Epon" epoxies. Hercules Powder Co. (now operating Allegany Ballistics Lab) is locating a new propellant facility at Bacchus, Utah (near Salt Lake City). The B. F. Goodrich Chemical Co. is said to be doing fuel-binder work at its Rialto, Calif. location. More solid propellant activity may be shown by Atlas Powder, Dow Chemical, Goodyear, Monsanto, and Rohm & Haas in the near future.

Too much work on fuel-binders? High-level sources feel that not enough effort is being devoted to new solid oxidizers. Most of today's solid oxidizers have been known for over 100 years, while modern fuel-binders have been researched and placed into operation during the last ten years. Unless new oxidizers come along, solids will soon plateau at about 275 sec., and thus be below the fluorine or ozone liquids by about 50 sec.

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René 41 is readily available from Cannon-Muskegon in sheet, bar stock and wire forms. Sheets may be obtained "as rolled" or polished... sizes up to 48 x 120 in.... thicknesses down to .010 of an inch. For complete details, mail the coupon below.

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Number Three of a Series



ARTHUR F. "ART" MATTHEWS has been an invaluable member of the F-101 "Team," serving as Assistant Project Engineer over power plant, hydraulics, controls and landing gear. Art and his group displayed a high degree of ingenuity in solving the many hundreds of mechanical design problems encountered in developing the F-101. He was recently appointed Project Development Engineer, and in this capacity monitors all development test programs related to the Voodoo airplanes.

From one basic design has grown the versatile Voodoo family of jet fighters pictured above. First, the long range all-weather fighter-bomber F-101A, the fastest operational airplane in the world. Second, the RF-101 reconnaissance Voodoo, holder of three transcontinental speed records. The third member of the Voodoo family is the F-101B, a supersonic atomic missile-carrying interceptor.

MEN OF

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world astronautics



by Frederick C. Durant III

On Capitol Hill an intensive short course in astronautics is underway. Chaired by Majority Leader John W. McCormack (D.-Mass.), the 13-man House Select Committee on Astronautics and Space Exploration has been sitting daily for several weeks (as this is written). The Committee represents influential members from both sides of the House, including Minority Leader Joseph W. Martin (R.-Mass.).

Armed with basic space flight literature, the Committee has been quizzing scientists plus top military and civilian engineers at the rate of four a day. For the most part, each witness reads a prepared statement airing his personal views and suggestions on the President's recommended NACA-NASA legislation, then submits to questioning and cross-examination.

These public hearings are one of the best shows and least attended affairs in Washington. Often members of the press will equal or outnumber the audience.

Chairman McCormack and his associates are tackling the review and consideration of the proposed NASA bill with heartening vigor. It is apparent that Congress appreciates the importance of legislation affecting U.S. development of astronautics. Most faithful attendee is Rep. James F. Fulton (R.-Penna.), and nearly all members question each witness.

The staff of the Committee is led by New York lawyer George J. Feldman, ably assisted by Dr. Charles S. Sheldon II. Head of the Committee's scientific evaluation group is Prof. S. Fred Singer, world-famed originator of the *Mouse,* and one of the most active and productive U.S. scientists in astronautics.

North of the border, a Canadian Astronautical Society has been chartered. Springing from the ashes of the Canadian Rocket Society (defunct since 1953), the CAS offers hope to many space-minded Canadians who were without an organized professional voice.

An initial meeting was held last March, attended by 61 persons representing 18 industries. Dr. Philip A. Lapp, senior electronics engineer at De Havilland, is acting president. Six men have been appointed to the 12-man council, including David Wallis of Avro.

The Society already has an active experimental program to develop a three-stage sounding rocket. A one-half to three-quarter lb. payload will be fired to 100,000 ft., telemetering three channels (temperature, pressure and acceleration). The first stage motor, under static test, uses a composite solid propellant.

For further information, address: A. E. Maine, secretary, c/o Guided Missile Division, De Havilland Aircraft of Canada, Toronto.

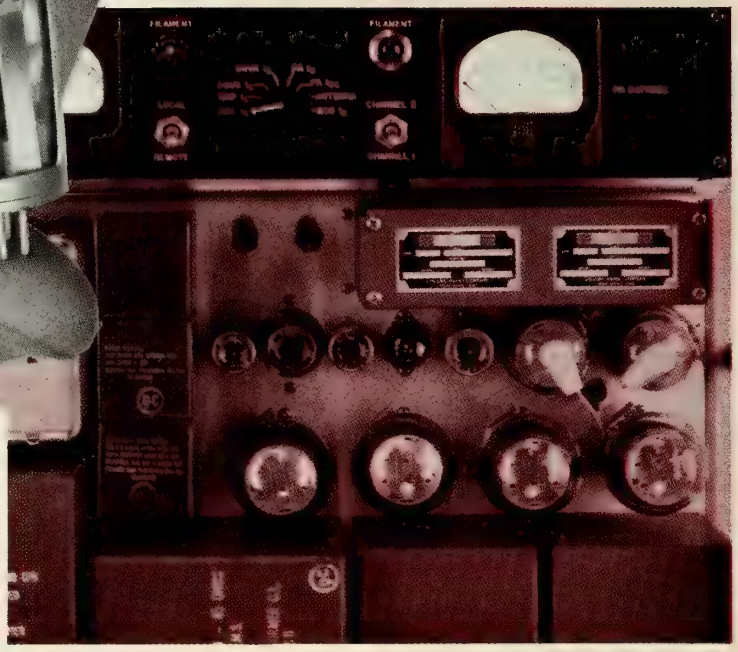
Quote of the month: Arthur C. Clarke, in a major British space-age conference for youth, looked out over the audience and said, "Some of you may have grandchildren born in space." In sixty years? It's conceivable!

THOMAS A.

EDISON'S

model 250 miniature time delay relays are shock and vibration resistant





As heater causes the expansion member to stretch, lever pivots on its hinge, compressing the bow spring at a high rate in the direction of contact closure. Matching expansion member compensates for external changes in temperature between −65 and +100°C.

Designed to meet military requirements, Edison's line of miniature time delay relays are available for a wide range of electronic applications.

The 250 Series Time Delay Relays combine in one unit superior design, top workmanship and performance at lowest cost. Check these advantages:

- Designed to withstand vibration frequencies to 500 CPS.
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NATO Graduation





Last month, the first class of North Atlantic Treaty Organization students—12 officers and 48 enlisted men from the Italian Army—graduated from the U.S. Army's Ordnance Guided Missile School at Huntsville, Ala. The Italians return to Italy expert in NIKE AJAX and NIKE HERCULES. Altogether, including U.S. Army, Air Force and NATO students, OGMS will graduate close to 5,000 missileers this year in NIKE AJAX and HERCULES, CORPORAL, REDSTONE, LACROSSE and JUPITER. Next year, the number of graduates will exceed 10,000. Total NATO students will rise from a current class of 200 to over 2,000; representing 10 nations: Canada, Denmark, Norway, France, Italy, Britain, Turkey, West Germany, Netherlands and Greece. American students, upon graduation, for the most part go right into active service with their birds. NATO graduates, however, upon returning to their homelands, will play the double role of missile squadron personnel and instructors. The pictures on this page were taken recently and show some of the students and their activities. Instruction includes layout and theory in the classrooms, assembly and disassembly in the shops, field practice, and finally the actual firing. For more pictures of missile people at their work, see p. 166.

Photography by Seabrook Hull





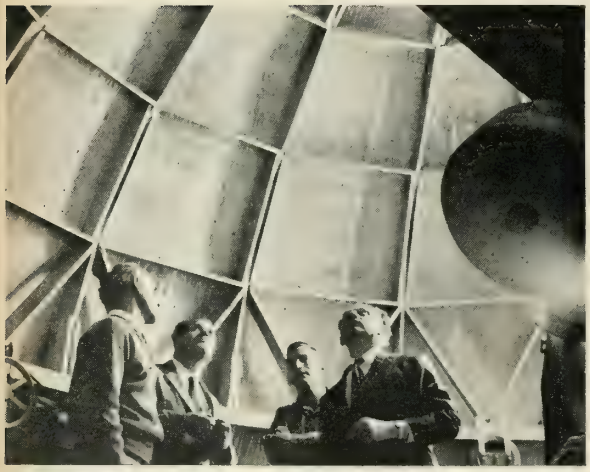






"We want to see where we're going . . ."

In a secluded corner of Monte Sano state park overlooking the thriving city of Huntsville, Ala., there rises an unusual structure—a small masonry cube topped by a carefully-constructed silvery dome. This is the observatory of the Rocket City Astronomical Association, whose president is Dr. Wernher von Braun. Built entirely by the members of the RCAA, the star-gazing site boasts a 14-inch reflecting telescope, complete with synchronously rotated dome, reinforced concrete mounts, photographic capabilities and over a dozen moon-watch sites. To the members of RCAA, the observatory has a very special significance. Many of the hard core of working members and founders earn their living at the Army's Redstone Arsenal—where they make not only missiles, but the hardware to take man into space.









Now four of the men who "want to see where they're going"—in the picture of the moonwatch site, to the immediate right, stand four of RCAA's regular members (l. to r.): George A. Ferrell, RCAA Sec. and Engineer, ABMA Guidance & Control Lab.; Dr. Conrad D. Swanson, v.p. of RCAA and chief of Analytical Investigations Section of ABMA Structures and Controls Lab.; Wilhelm Angele, chief architect and Engineer for RCAA and chief of ABMA's Precision Instrument Branch; and last but not least, Dr. Ernst Stuhlinger, RCAA physicist and research consultant, and chief of ABMA's Research Projects Lab.



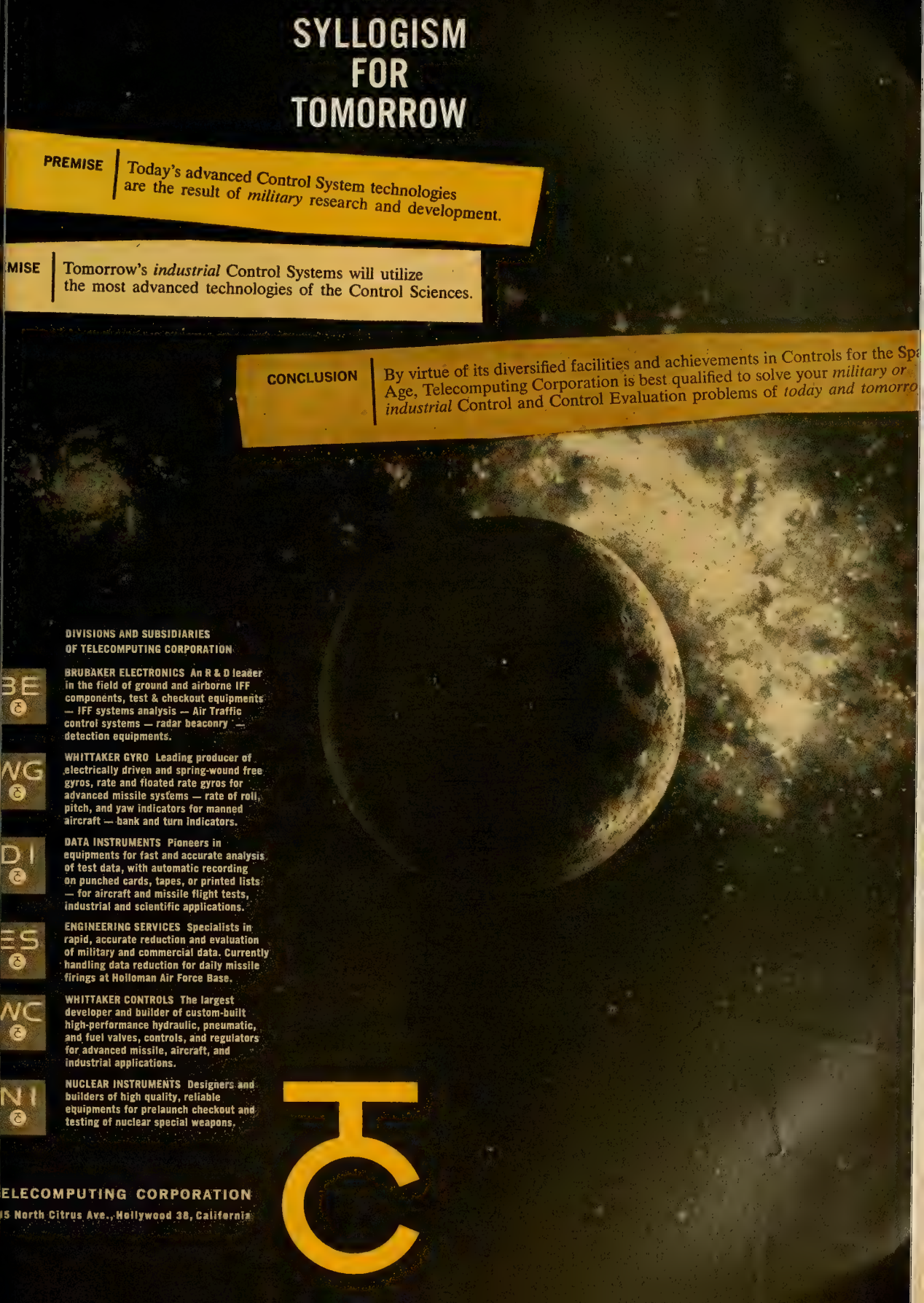
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Thomas F. D'Andrade has been appointed National Sales Manager for the Components Division of Fairchild Controls Corp. **D'Andrade** will direct the sales program for all plants of the Components Division.

W. Wayne Hill has been assigned as executive technical advisor to the Toyo Communication Equipment Co. of Kawasaki, Japan by Packard Bell Electronics Corp.

Rear Admiral Ford Newton Taylor, Jr. USN (Ret.) has been named Director of Washington Operations by Fairchild Camera and Instrument Corp.

Hugh A. Young, has joined Packard-Bell Electronics Corp. as sales manager of the Technical Products Division. He will coordinate the activities of sales engineers and branch managers in Washington, D.C., New York City and Rome, N.Y., Dayton, Ohio, Fort Monmouth, N.J. and Los Angeles, Calif.

W. W. Roodhouse, Collins Radio Co., has been advanced to General Sales Manager, and **R. C. Frost** has been appointed Director of the International Division. **T. W. Sharpe** was appointed as Assistant General Sales Manager, and **R. M. Winston** as Assistant General Sales Manager, Administration.

Frank L. Spencer was appointed assistant manager of engineering program development for the Technical Products Division of Waste King Corp., Los Angeles.

C. Gould Wheeler, W. Ralph Wilcox, and **Michael R. DeLallo** have been named managers to the General Electric project team that will supervise the engineering, production and installation of the ballistic missile radar system. **Mr. Wheeler** will plan, organize, and implement all material purchasing and control for the super radar system. **Mr. Wilcox** will plan, organize, schedule and implement the production and fabrication of all equipments needed for the giant radar system. **Mr. DeLallo** will be in charge of administration for the Missile Detection Systems Section.

Robert J. Sloan has been elected president of Crouse-Hinds Co., Syracuse, N.Y. **Raymond W. Cummings** was elected to the position of secretary of the company.

Walter K. Deacon has been appointed Chief Engineer, Torrance Plant, of the Aero Hydraulics Div., Vickers Inc.

Charles F. Hoell has been appointed Controller of American Bosch Arma Corp.

Col. Benjamin S. Mesick, USA (Ret.) has joined the Grand Central Rocket Co., as Assistant to **President E. Bartley.**

Capt. Charles E. Trescott, USN (Ret.) has been appointed vice president and general manager of Zenith Plastics Co., subsidiary of Minnesota Mining and Manufacturing Co. **Trescott** will be responsible for all operations of the southern California plastics firm.

Dr. Robert Finn, associate professor of mathematics, **Dr. Yuan Cheng Fung,** associate professor of Aeronautics, **Dr. Guido Munch,** associate professor of astronomy, and **Dr. John Laufer,** JPL research specialist, members of the staff of California Institute of Technology and the Jet Propulsion Laboratory have been awarded Guggenheim Fellowships.

Dr. Roger S. Estey has joined the technical staff of Nortronics as a research scientist.

Ames F. Giordano has been appointed Chief Engineer to Blonder-Tongue Laboratories, Inc. He will be responsible for the development of the Company's products.

Robert H. Jewett has been named assistant general manager—chief engineer of the Boeing Pilotless Aircraft Division. **Jewett** will have charge of four divisional departments.

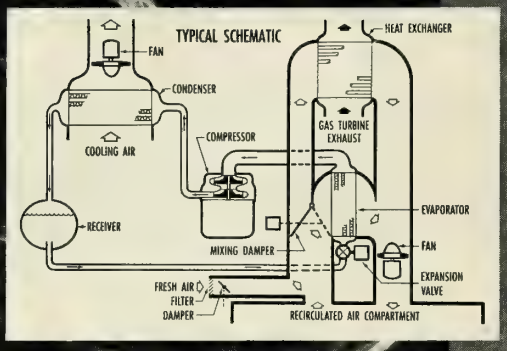
Dr. Milton U. Clauser, Allen F.



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LIGHTWEIGHT

air conditioning for missile support systems



The mobility problem in cooling electronic equipment in vans and for missile pre-launching has been answered by new AiResearch Freon air conditioning units. *One-fourth the weight and one-third the size* of conventional equipment, these lightweight, air-transportable units utilize highly efficient AiResearch Freon components (see diagram) originally developed for commercial aircraft applications.

Heat source for the circuit can be either electrical, or exhaust gas from an AiResearch gas turbine. When the gas turbine assembly includes an alternator, it supplies *400 cycle power to run both the refrigeration unit and all electronic gear in the van.*

Easily operated manually or automatically, this compact air conditioning unit provides from 5 to 12 tons cooling capacity and up to 85,000 BTU's per hour heating capacity. It operates on 400 cycles, 208 volts. The unit shown stands 54″ high, 52″ wide and 27″ deep, with a charged weight of only 452 lbs.! Your inquiries are invited.

SPECIFICATIONS

Performance Data:

Typical operation—cooling

Refrigerant	Freon 12
Evaporator tonnage	7.5
Ambient temperature	100F
Condenser air flow	5000 cfm
Condensing temperature	131F
Evaporator air flow	1230 cfm
External distribution ducting pressure drop	2 in H_2O
Evaporating temperature	48F
Electrical power	26KVA

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. . . missile people

Donovan, and **William F. Duke** have been elected vice presidents in Space Technology Laboratories, a division of The Ramo-Wooldridge Corp.

Dr. Chuck Ching Ma, Dr. Ernest Mayer, and **Dr. Gadicherla Rao** have been appointed engineering specialists by Rocketdyne, division of North American Aviation. **Dr. Gadicherla Rao,** noted research psychologist, has been appointed design analyst.

Carl L. Lang was named Joint-Ventures Manager at Page Communications Engineers, Inc. He will direct telecommunication projects now under way in Korea, Libya, and Southeast Asia.

Curtis W. Symonds has rejoined Sylvania Electric Products, Inc. as controller of the company's Semiconductor Division.

C. J. Thompson has been appointed district sales manager for Aeronautical and Instrument Division of Robertshaw-Fulton Co. His territory includes California, western Nevada, Washington and Oregon. He is also in charge of foreign sales.

Richard A. Terry has been named manager, advertising and sales promotion for Telemeter Magnetics, Inc., Los Angeles, Calif.

Robert W. Dillon has been named West Coast sales representative for the Vitro Weapon Systems group, Vitro Corp. of America.

Carl J. Theken has joined the Cyril Bath Company as Treasurer and Assistant Secretary.

Dr. John R. Ragazzini has been named dean of New York University's College of Engineering.

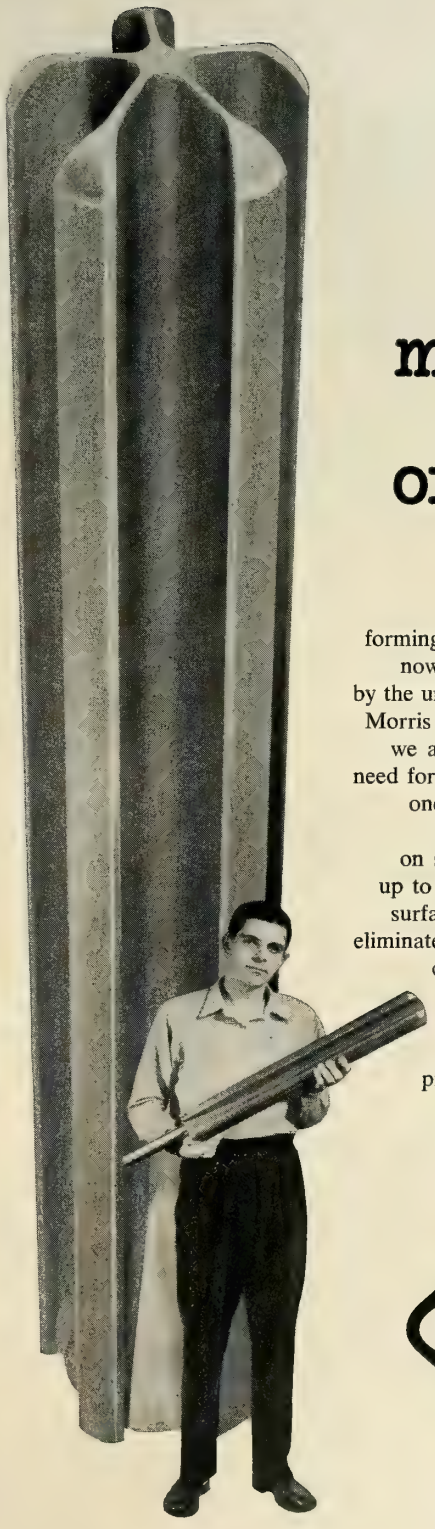
William A. Stevenson has been named to direct design of the Navy's Polaris ballistic missile, being developed by Lockheed Missile Systems division. He will be in charge of structural and internal systems design of the missile.

Wilbur R. Hankes has been appointed Director of Military Relations by Avco Research Laboratory. He will represent the interests of the Laboratory in liaison with the various elements of the Department of Defense.

Col. Kenneth W. Klise (USAF-Ret.) has joined Page Communications Engineers as a project manager.

William N. Snouffer has been appointed manager of the Plato anti-missile missile system by Sylvania Electronic Systems, a division of Sylvania Electric Products Inc.

Paul Helweg has joined the Electronics Department of Hamilton Standard Division, United Aircraft Corp., Broad Brook, Conn. as assistant sales manager. He will assist in the development of the sales programs concerned



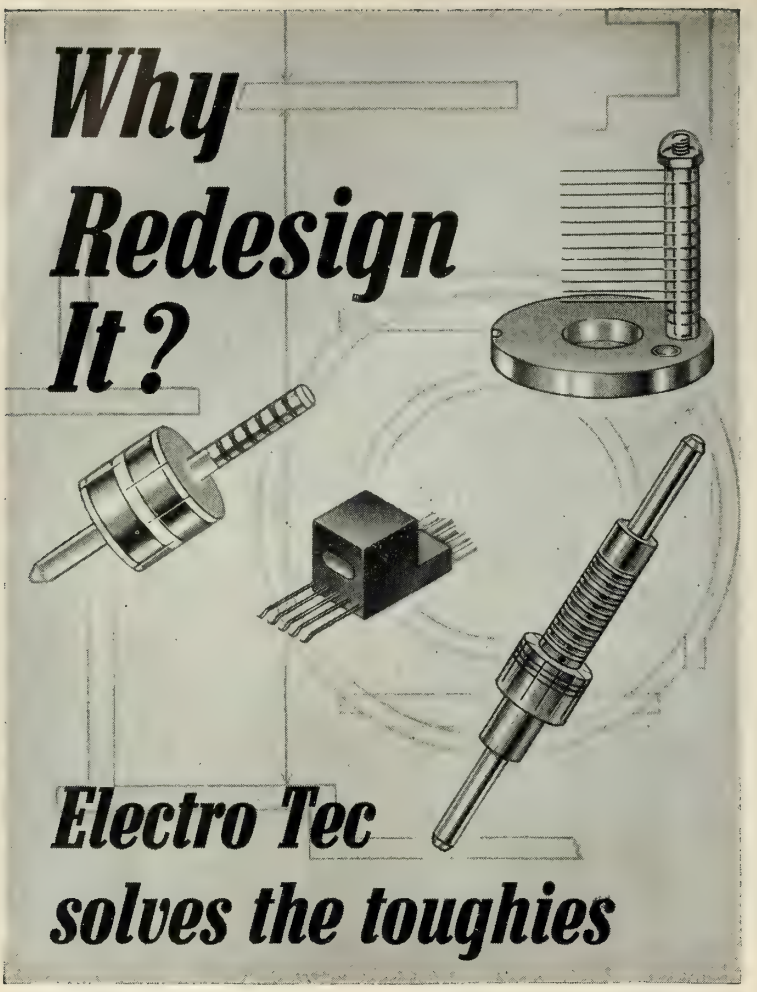
cast mandrels or cores?

Aluminum mandrels for forming solid fuel propellant are now being cast in production by the unusual foundry methods of Morris Bean & Company. While we assume there is no present need for a mandrel as large as the one on the left, it *can* be cast. Currently we are working on solid and hollow mandrels up to 8 feet long. Their smooth surfaces and accurate contours eliminate much difficult machining; cost is drastically reduced. In addition to large size, we would be happy to explore with you ways to produce intricate star-lobes. *Telephone or write.*

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Because of Electro Tec's precision manufacturing techniques, you can be sure that each and every brush assembly will be uniformly top quality and will be held to absolute tolerances. Exact control of tolerances provides unparalleled uniformity, including contact pressures and space alignment. Because of the interchangeability of these parts you can standardize your inventory at lower cost!

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Write for illustrated literature.

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. . . missile people

with the design and development of missile weapons systems and airborne electronics systems and components.

Dan T. Buist was elected Vice President-Marketing by Turco Products, Inc. **Archie K. Beard** was appointed General Sales Manager and **Steward B. Van Dyne** was named as Assistant to Vice President-Marketing.

Tom J. Venator has been named chief applications engineer of the Electronic Systems and Equipment element of Nortronics, division of Northrup Aircraft, Inc.

Maj. Gen. Harry Reichelderfer, (ret.) was named assistant director of Southwest Research Institute by the executive committee of the Institute's Board of Governors. He was formerly an assistant vice president of the organization.

William M. Richardson has been named assistant to the vice president and will head the Washington office of BJ Electronics, Borg-Warner Corp. Formerly with Ramo-Wooldridge Corp. as Washington representative, Richardson will be responsible for technical liaison with Department of Defense, military services and other government agencies involved in electronic research and development.

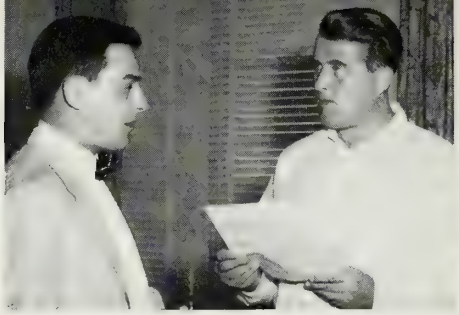
William J. Seevers has been appointed assistant to the general manager by the Bell Aircraft Corp. Seevers, former assistant to President Leston Faneuf for industrial security and military liaison, joined Bell in September 1952, as staff assistant to President Lawrence D. Bell.

W. G. Lundquist, has been retained by Reaction Motors, Inc., Denville, N.J., as technical consultant and advisor on the Pioneer rocket engine. Lundquist has been vice president of engineering for all divisions of Curtiss-Wright Corp.

NEW PRESIDENT of the Huntsville Industrial Expansion Committee, Robert K. (Buster) Bell, here makes a point with Revis O'Neal, PIO of the Ordnance Guided Missile School. Bell replaces C. W. Jones as head of HIEC.




Meet the editors who have made
Missiles and Rockets the first,
biggest, and best magazine
in the missile market
1st
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. . . 23,800 PAID subscribers.
in ad volume
. . . over *twice* the advertising
pages of its *nearest* competitor.
in weekly coverage
. . . of the zooming missile market,
starting July 7, 1958.
Here are the men who provide fresh, vital, timely, informative, interpretative articles for Missiles and Rockets subscribers . . . the influentials of the missile market.
Here, at work, are the men who bring together a high quality audience . . . eager to learn more about the missile market.

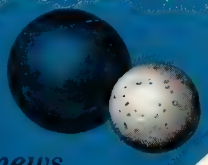


Associate Editor Seabrook Hull (Finance & Business) visiting with ABMA's Technical Director, Dr. Wernher von Braun (Chief Guided Missile Development Division, ABMA), right.

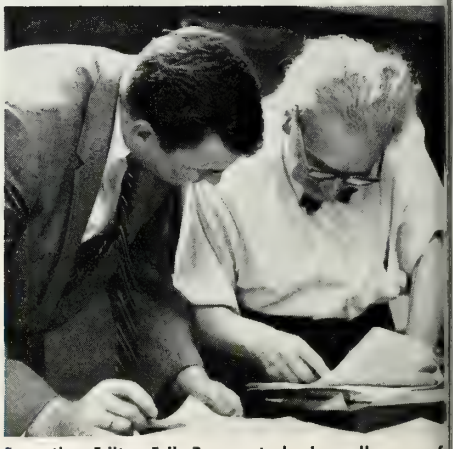


Associate Editor Norman L. Baker (Engineering an Production) interviews Douglas Aircraft's Presiden Donald W. Douglas Jr., left, about missile produc bility.

these M/R editors have travelled more miles than from earth to moon



to get you on-the-spot news coverage since Missiles and Rockets was launched October 1956 . . .



Executive Editor Erik Bergaust checks galley proof with Air Force and NATO Chief Scientific Advisor world renowned Professor Theodore von Karman right.



Associate Editor Alfred J. Zaehringer (Chemistry & Propulsion) and "Mr. Redstone" — Chrysler's Lowell Lawrence, right — check new propulsion systems.



Assistant Editor Erica Cromley interviewing Robe P. Haviland, left, Advanced Systems Engineer Satellites, MOSD, General Electric Co.



Electronics Editors Peer Fossen, left, and Raymond M. Nolan, right, discuss interplanetary communication and space guidance with Convair Astronautics' Krafft A. Ehricke.



Managing Editor E. E. Halmos, Jr., left, goes over some last minute news stories with Assistant Editor Donald E. Perry.



Associate Editor William O. Miller (Military & Legislative) checking out an underwater missile story with Navy's Rear Admiral K. S. Masterson, right.



Asssistant Editor Frank G. McGuire, left, discussing orbits with Dr. John P. Hagen, Director of Project Vanguard.

—check their exclusives

The first news story that m/r ever published indicated that the Army would launch a satellite before *Vanguard.* (m/r 10/56) ("Army to Launch 'Satellite' Before *Vanguard?")* • Jupiter-C Flight of 3000 miles (Nov. 56) ("Outstanding Army Rocket Record") • "Break-up in Army-Navy *Jupiter* Program" (1/57) • "Manned Rocket Bombers Underway." (2/57) • "USAF to Start Moon Rocket Program." (3/57) • "Undersea Warning System Underway." (5/57) • "Navy *Polaris* Test Vehicle Fired." (10/57) • "Russia's Moon Rocket Program." (11/57) • "SAC Gives U. S. Advantage over USSR." (1/58) • "Sweden Developing Atomic Missiles?" (2/58) • "Kapustin Yar Serves as Russia's Cape Canaveral." (2/58) • *"Snark* Disclosures Fit With Carrier-Base Plan." (3/58) • "Navy Pushing New Subroc Missile." (4/58) • "Extension of HERALD Systems Planned." (4/58) • "Polaris Details Revealed." (5/58).

—check their qualifications

ERIK BERGAUST, Executive Editor: BS in chemistry; Author of a number of books, including "Next 50 Years of Flight," "Rockets and Missiles," and (with a co-author) "Satellite." President of the National Rocket Club; Director of the Washington section of the Aviation Writers Association and Director and past President of the Washington section of the American Rocket Society; Chairman, Press Committee, International Astronautical Federation; Member of the Information Advisory Group of the President's Committee on Scientists and Engineers.

E. E. HALMOS, JR., Managing Editor: 16 years as Managing Editor and Senior Editor, Engineering News Record; newspaper experience including United Press Associations; The Salt Lake Tribune; Navigator, 8th Air Force, World War II. Member of the National Press Club.

SEABROOK HULL, Associate Editor: Union College; Naval Aviator USMC, World War II; Editor of "Foreign Letter," the Whaley Eaton Service; Chief of London Bureau, McGraw Hill World News.

NORMAN L. BAKER, Associate Editor: BS in Aeronautical Engineering; News Editor and correspondent for "Jet Propulsion." Development engineer in the Pilotless Aircraft Division of Boeing Aircraft Company; Secretary, National Capital Section, American Rocket Society; Past President of the Ft. Wayne Section of the American Rocket Society; Member of the Institute of Aeronautical Sciences, American Astronautical Society, American Ordnance Association and National Rocket Club.

RAYMOND M. NOLAN, Associate Editor: Formerly with Ford Instrument Company Division of Sperry Rand Corporation; Writer for USAF; Member of the Aviation Writers Association, National Rocket Club, American Society of Military Engineers.

WILLIAM O. MILLER, Associate Editor: Cmdr., USNR, recently on active duty as head of the Radio and Television Branch, Office of Chief of Information; over 10 years newspaper and editorial experience.

ALFRED J. ZAEHRINGER, Associate Editor (Propulsion and Chemistry); President American Rocket Co.; BS in Chemistry; Formerly Associate Editor "Jet Propulsion"; Rocket engineer, Thiokol Chemical Corp.; Chemical engineer, Grand Central Rocket Co.; Past president, secretary and technical director of Detroit Rocket Society; American Chemical Society; American Ordnance Association; American Rocket Society; Chicago Rocket Society; Gessellschaft fur Weltraumfahrt.

PEER FOSSEN, Associate Editor: Formerly with Page Communications Engineers, Inc.; Associated with Army and Air Force technical publications, member of American Rocket Society, National Capital Section.

DONALD E. PERRY, Assistant Editor: Public Relations with The Martin Company, Orlando, Florida; Served as Aviation Editor for several southern and midwestern newspapers; Member of Aviation Writers Association and the International Society of Aviation Writers.

FRANK G. McGUIRE, Assistant Editor: BA in Russian Studies and Journalism; member of American Rocket Society. Numerous articles in Encyclopedia Britannica.

ERICA CROMLEY, Assistant Editor: Formerly with New York Daily News; Washington Bureau of Buffalo, N.Y., Courier Express; London Daily Express.

ELLEN ROSENBLOOM, Assistant Editor: Graduate Syracuse University with BA Journalism; Graduate Studies at Cornell University. Formerly with United Press Associations; Bureau of National Affairs.

... over

plus *contributed* articles by such outstanding missile experts as these . . .



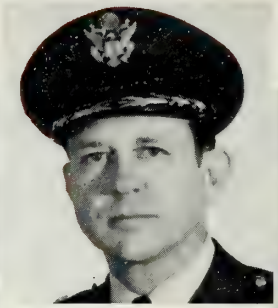
or General August Schom-
g (Asst. Chief of Ordnance,
earch and Development, USA)



Rear Admiral James S. Russell, USN (Chief Bureau of Aeronautics, USN)



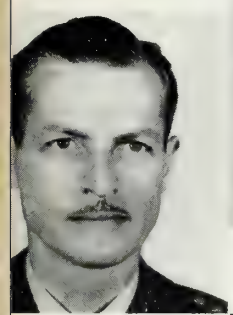
Major General J. B. Medaris (Ordnance Missile Command)



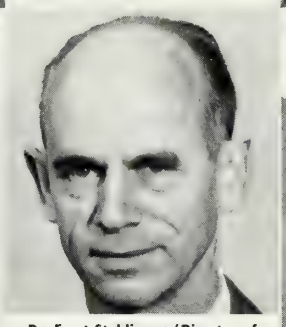
Brigadier General Hollingsworth F. Gregory (USAF — OSR)



Rear Admiral John E. C
(Deputy Director, ARPA)



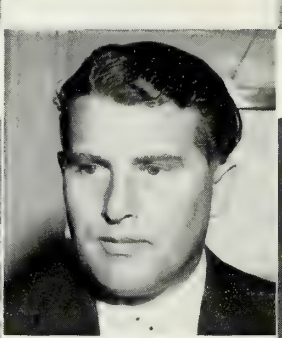
or General Otis O. Benson,
(Commandant, School of
ation Medicine)



Dr. Ernst Stuhlinger (Director of Research Projects Office, ABMA)



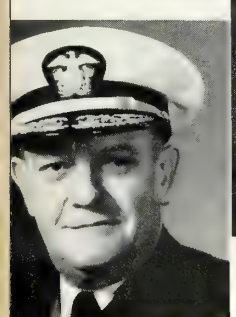
George P. Sutton (Chief, Preliminary Design Section, Rocketdyne)



Dr. Wernher von Braun (Chief Guided Missile Development Division, ABMA)



Major General David H. Tu
(US Army Engineering Cen
Fort Belvoir, Va., USA)



r Admiral Rawson Bennett
ief, Office of Naval Research)



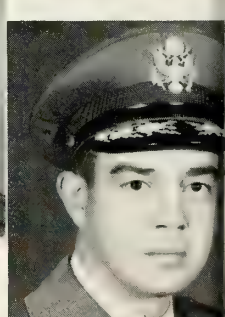
Commander George W. Hoover (Office of Naval Research, USN)



William P. Lear (Chairman of the Board, Lear, Inc.)



Major General B. A. Schriever (Commander, Western Development Division, USAF)



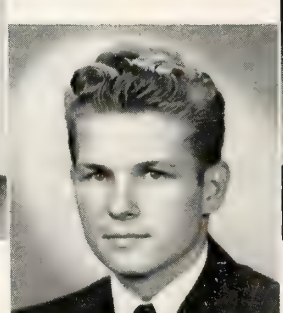
Brigadier General Don R.
trander (Assistant Deputy C
mander for Weapon Syst
Hq., Air Research and Deve
ment Command)



rt R. Stehling (Head of Pro-
lsion, Project Vanguard, Na-
l Research Lab.)



William Mitchell (Section Superintendent, Reaction Motors, Inc.)



W. C. Rous, Jr. (Senior Mfg Res.
Engineer Convair, Fort Worth)



D. C. Romick (Head, astronautics section Weapon System Dept., Goodyear Corp.)



Rudolf Reichel (Special W
pons Preliminary Design E
neer, Bell Aircraft Corp.)

book reviews

ADVANCES IN GEOPHYSICS, Vol. 4 by H. E. Landsberg and J. Van Mieghem, 456 pp., $12, Academic Press Inc., N.Y.

Public interest in the International Geophysical Year has brought an obscure area of science into the spotlight —geophysics—and keeping up with the rapid progress in the field, this volume furnishes new knowledge of earth science to student and teacher alike.

The book details atmospheric chemistry, theories of the aurora, effects of meteorites upon the Earth (including effects upon inhabitants, atmosphere, and satellites), smoothing and filtering of time series and space fields, and Earth tides.

The authors not only report progress in geophysics, but also indicate questions which remain open and avenues of future research.

SPACEPOWER, WHAT IT MEANS TO YOU by Donald Cox and Michael Stoiko, 262 pp. $4.50, The John C. Winston Co., Philadelphia, Toronto

Why go into space? Who owns space? Who owns the universe? These questions, and many others, are answered in SPACEPOWER. The book examines the problems which now face man—moral, legal, political, economic—in the fantastic new world of the Space Age.

This is not a technical treatise on rockets and missiles, nor is it science fiction. It offers a realistic analysis of the social, military and legal aspects of space penetration, plus the first concrete proposal for the control of space through a United Nations force. The book also offers a complete spaceflight timetable outlining man's ultimate conquest of the Universe.

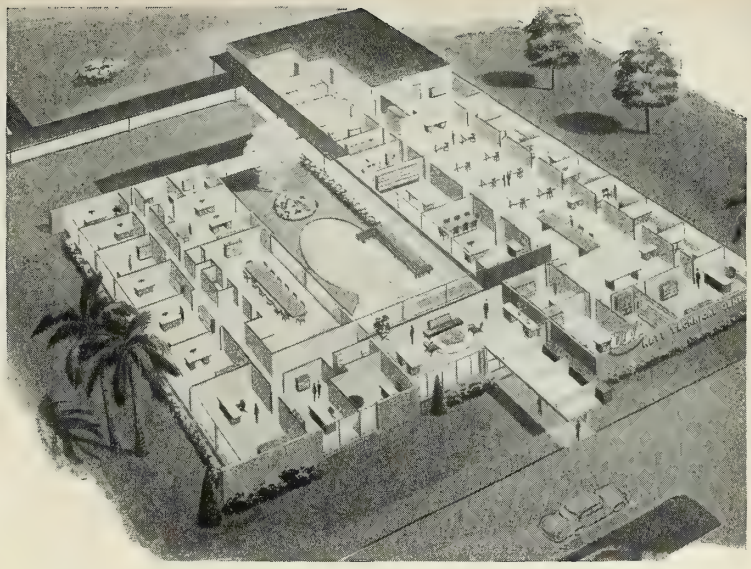
SPACEPOWER is well illustrated with full-page diagrams and drawings.

ROCKET BUILDING FOR STUDENTS by Rocket Research Institute, Inc., Sacramento, Calif., $2.

This manual, an updating of a similar booklet published by the Institute in 1948, presents safe and inexpensive methods of preparing and launching rocket training devices for the student.

Due to the increased interest in rocket and space sciences, the Institute feels that youngsters will continue to construct rockets regardless of warnings, ordinances, or the difficulty of obtaining materials. This manual should enable experimenters to conduct tests without accidents, often sometimes tragic.

The manual gives good basic advice



Designed for CREATIVE THINKING

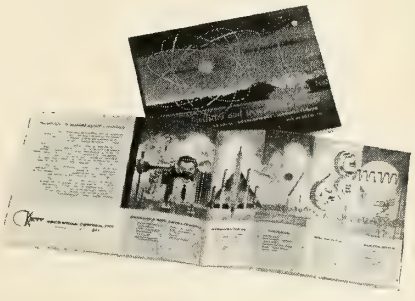
Here is a facility that was designed from the ground up to stimulate creative engineering—the new Kett Technical Center, a subsidiary of U.S. Industries, Inc.

Although the buildings are new, Kett is no new-comer to Research and Development. Its research achievements are already widely recognized in the fields of Nuclear, Aeronautical, Electronic and Mechanical Engineering.

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Write for this book.

The facilities at the Kett Technical Center and the major facilities for manufacturing offered by U.S. Industries divisions are described in this recently published book. Write to Kett Technical Center, Pompano Beach, Florida.

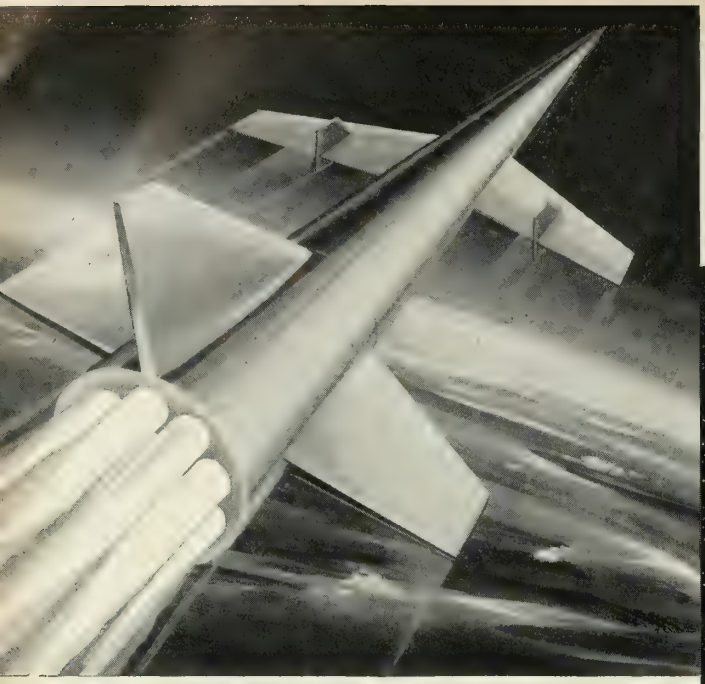


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BELL Aircraft CORP.

VISIT BELL'S EXHIBIT AT THE ASTRONAUTICAL EXPOSITION, STATLER-HILTON HOTEL, LOS ANGELES, JUNE 9, 10, 11.

. . . book reviews

and the fundamentals of rocketry. It covers safety precautions, organization of student groups under adult supervision, safe construction, launching of small-scale rockets, and preparation of fuse and electric ignition boxes.

THE OPTICAL INDUSTRY DIRECTORY, The Optical Publishing Co., Brewster, N.Y., 292 pp., $5.

This is a handy reference volume covering manufacturers, distributors and designers of the optical industry.

The book lists American optical sources and gives an item index of optical products and services; including instruments, components, raw materials, special services and manufacturing equipment.

Also included is an area listing of companies furnishing the indexed item. A valuable feature of the volume covers industry personnel and their affiliations.

A lens appendix lists commercially available lenses for photography, projection and optical instrumentation.

GUIDED MISSILES—OPERATIONS, DESIGN AND THEORY. Sponsored by U.S. Air Force, 575 pp. $8.00. McGraw Hill Book Co., New York.

This treatise does an impressive job of laying out the elements of current missile design and operation. In a style and format that is pleasantly presented, this book—except for the fact that there is no list of questions at the end of each chapter—could be an advanced college text book. Assuming that the reader has some knowledge of chemistry, electronics, areodynamics, etc., it sets out to introduce the interested and somewhat experienced student to the why's and wherefore's of the various approaches to guided missilery.

Employing a modern, clean, layout, liberally interspersed with drawings and diagrams, "Guided Missiles" covers in an orderly fashion all the unclassified details of propulsion major subsystems (such as guidance, control, aerodynamics, physics, optics, telemetry, etc.) as well as some of the detail sub-sub-system requirements—sensors, reference units, amplifiers, followup units, actuators, computors, hydraulic-electric systems, trajectory, short and long-range guidance, terminal guidance, etc.

Also covered is that all-important subject of guided missile tactics. However, it is primarily a book to introduce the reader, in quite a detailed fashion, to guided missilery.★

NEWS FROM FLEXONICS

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One of a series of reports to help you make more effective use of Flexon products.

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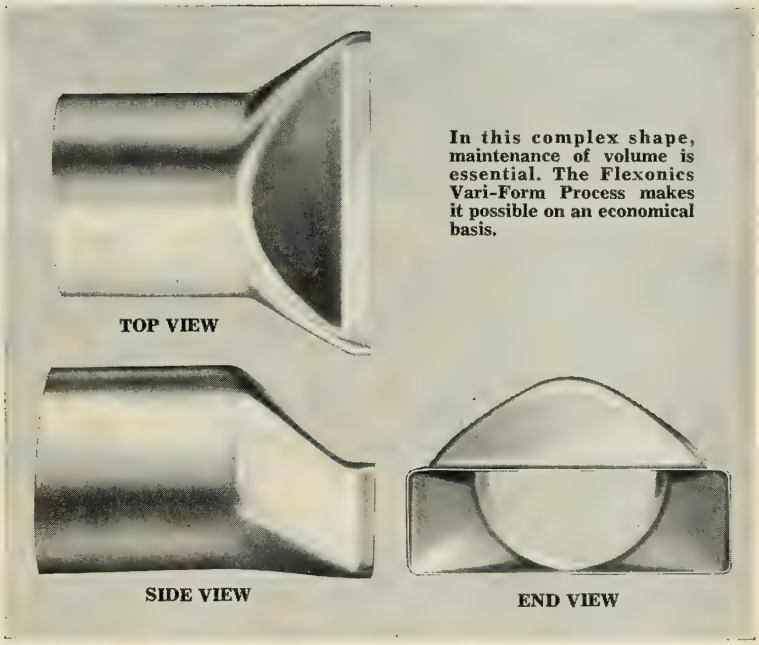
As the geometry of ducting becomes increasingly complex, forming problems are compounded. Maintaining equivalent volume becomes difficult through a variety of transitions in shape. These considerations added to the long standing problems of weight, strength, heat resistance, etc. make ducting system design a severe test of ingenuity in fabrication.

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A representative group of shapes formed by the Vari-Form Process.



In this complex shape, maintenance of volume is essential. The Flexonics Vari-Form Process makes it possible on an economical basis.

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Advantages in Production

Flexon Vari-Form Ducting Components are made to very close tolerances, eliminating bad fit-up. Costs are held in line because Vari-Form Components can be made in any quantity from 1 to many thousands with minimum tooling expense.

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If you have unusual ducting or piping problems, you can take advantage of Flexonics Corporation's experience. As the nation's most experienced manufacturer of metallic plumbing components for aircraft, rockets and missiles, Flexonics is qualified to help you in the most advanced design problems.

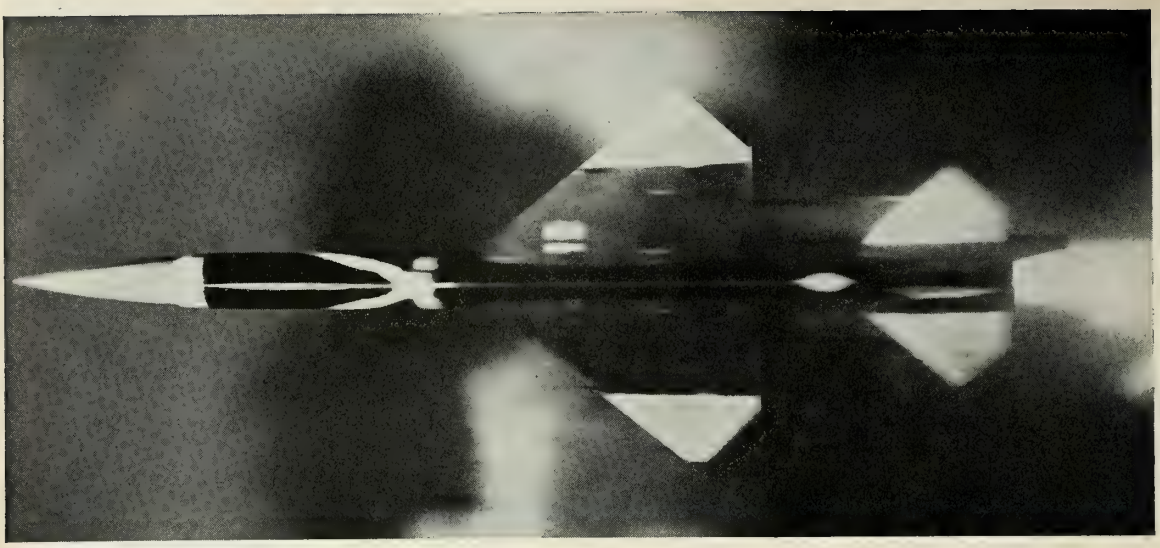
It will pay you to learn more about the Vari-Form Process and how it can serve you. For specific recommendations send an outline of your needs.

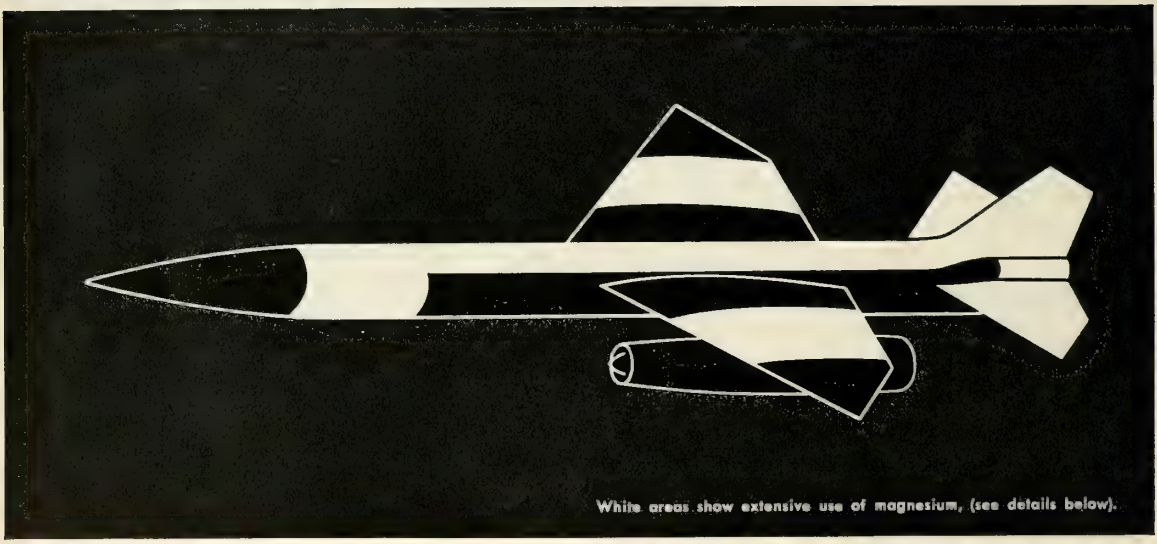
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AERONAUTICAL DIVISION
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HOW ELEVATED-TEMPERATURE MAGNESIUM ALLOYS HELP BOMARC KEEP FIGHTING WEIGHT

Approximately 230 lbs. of magnesium is used in the airframe of the Bomarc, powerful surface-to-air missile. And for good reason: In each case, the specific application called for light weight and retention of strength, rigidity and other properties at elevated temperatures. The logical choice was sheet, extrusions or castings of elevated-temperature magnesium alloys.

EXAMPLES:

BODY. The body skin and doors of both nose and aft sections utilize 103 lbs. of HK31A sheet and castings. Resultant weight savings were 23 lbs., including a net reduction of 6 lbs. by using a magnesium casting for a door frame structure.

WING, FIN AND TAIL. 111 lbs. of HK31A sheet were used in the wing, elevators and elevator stubs, fin and rudder. All leading and trailing edges of control surfaces for wings and fin are HM31XA extrusions. Here another 8 lbs. were saved by using an elevated-temperature magnesium alloy.

These are but a few instances of how precious weight was saved in the Bomarc. For more information about the use of magnesium alloys in aircraft, rockets and missiles, contact the nearest Dow sales office or write directly to us. THE DOW CHEMICAL COMPANY, Midland, Michigan, Department MA 1407L-1.

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space medicine

by Hubertus Strughold, M.D., Ph.D.

As a result of several recent meetings, space medicine stays on top of the news.

A 24-lecture series on space technology for postgraduate students, completed in May, drew crowds of 400 to 1,800 students. The lectures, conducted by the department of Engineering and Physical Sciences, U. of California, in cooperation with the Ramo-Wooldridge Corp., were held in Los Angeles, San Diego, San Francisco, Lancaster (Edwards Air Force Base), and North Air Force Base, Calif.

Of special interest were the following lectures: "Physical Factors of Space Environment," by H. Haber, "Cabin Design and Personal Equipment" by A. M. Mayo, and "Man in Space Environment," which I delivered.

A recent report on interplanetary dust distribution advanced the theory that there is a localized increase in dust density around the earth due to the influence of the earth's gravitational field. This "blanket of dust" extends more than a million miles into space.

The report was presented by David B. Beard of the Lockheed Aircraft Corp., Missile System Division, at the spring meeting of the American Physical Society held in Washington, D.C. last month.

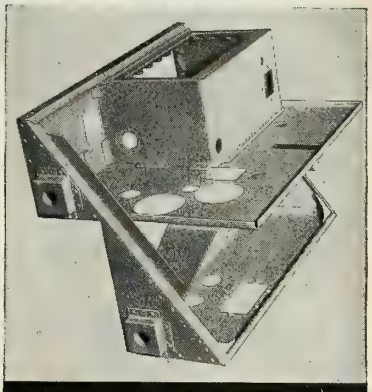
The million-mile "blanket of dust" figure is of special interest because it corresponds to the extension of the earth's sphere of predominant gravitational attraction. I called this extension "gravisphere" in "Spatiography: Geography of Space" (m/r, May, page 106).

It can be assumed that other planets show similar space dust concentrations within their gravispheres. The "gravitational territories" of the other planets are, of course, different in volume, and are dependent on their gravities and distances from the sun. The radius of the gravisphere of Mars and Venus is in the order of a half million miles; of the Moon about 30,000 miles, and that of Jupiter, 30 million miles.

The House Select Committee on Space Exploration heard testimony last month on the medical aspects of present and future space plans from Colonel Paul Stapp (now Chief of the Aeromed Lab, Wright-Patterson AFB, Dayton, Ohio) and myself.

Preliminary experimental results from US-IGY Satellite 1958 Alpha were reported last month at the National Academy of Sciences, under the chairmanship of Dr. Richard W. Porter. Of special space medical interest were the following findings: the picture of intra cabin temperatures by Dr. A. R. Hibbs, Jet Propulsion Laboratory, California Institute of Technology; and the problem of micrometeoritic impact by Dr. E. R. Manning, Air Force Cambridge Research Center. These findings look most optimistic.

MAGNESIUM?
TITANIUM?
STAINLESS?
ALUMINUM?



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We have more GSE* experience than anyone

...and now we can put it to work for you

***Ground Support Equipment— mainstay of modern weapon systems**

A strong statement? Yes. But we can back it up.

We were the first company to have complete responsibility for a major supersonic missile weapon system. The Navaho—America's pioneer long-range missile—produced such a wealth of technological data that the entire missile program now draws on it.

Ground support equipment for the Navaho and the X-10 developed a new concept for checkout trailers, engine run-up dollies, instrumentation checkout consoles, hydraulic servicing units, ground power units, jet engine starters, ground cooling carts, ground hydraulic power supplies, ground pressurization equipment, ground fire-fighting equipment, access and support stands, air transportation dollies, and a wide range of other test and launching equipment.

This was done through the ability to integrate numerous single elements into complete, smooth-running ground support systems.

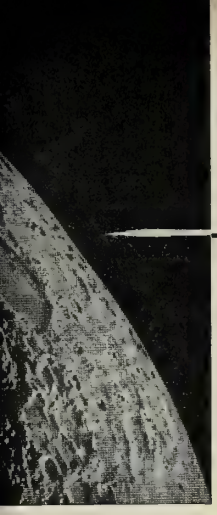
Specialized engineering and production skill and facilities in this new field are available to do an outstanding job for you, quickly and economically—on individual items or complete, coordinated ground support systems—either military or commercial.

Interested? Write or call Manager, Special Products, Missile Division, North American Aviation, 12214 Lakewood Blvd., Downey, Calif.

MISSILE DIVISION

North American Aviation, Inc.

Circle No. 78 on Subscriber Service Card.



missile miscellany

The other day this page heard what must be the shortest definition yet of a highly complex (yet increasingly popular) subject: Operations analysis consists of reducing alternatives. Still on definitions, there must be some kind of missile significance to the description that a camel is a greyhound designed by committee. In the same vein, these comments on the missile business by a servo-minded missile businessman: Performance and opportunity are connected in a very non-linear fashion . . . The financial loop for systems management is closed through the headlines. And a suggestion to start a "Journal of Astro-Politics"!

Fascinated at the contrast, this page now discovers that Diversey Engineering is buying a Monarch air gage tracer lathe with Keller attachments, with a facing plate over 90 in. in diameter and a bed 25 ft. between centers. At the same time, Detroit Controls is ordering a gyro production lathe accurate to plus-or-minus five millionths of an inch. Down in oil-rich Houston, Cameron Iron Works thinks it can produce precision high-strength, thin-wall rocket motor casings with its 11,000-ton main ram, 6,000-ton double side ram forging press. But watch out: the real answer lies in a unique variation on the spiral wrap! And if anyone thinks solid fuels are running the liquids out of business, stop and consider: AF is buying large cryogenic equipment to handle liquid hydrogen and fluorine.

Ever wonder how a *Polaris*-launching submarine would know where it was when ready to fire its birds, what with precessing SINS gyros, etc.? Well, Navy wondered, and as a result will install in each *Regulus* and *Polaris* submarine one Type XI periscope that will be able to take celestial shots automatically without the submarine having to surface and a radio sextant enabling a surfaced submarine to shoot sun and moon in overcast weather. These will CX SINS.

And down in the old south, suh, Huntsville is booming. AOMC chief Major General Medaris forecasts that its population will top 100,000 by 1965. Could be, since the General also says that construction on the Arsenal will continue at the rate of $1-to-$1.5-million a month for the foreseeable future. Redstone's payroll nudges $100-million a year for 18,000 employes, and AOMC now controls almost $3-billion in funds annually for its operations at Redstone Arsenal, ARGMA, ABMA, Fort Bliss, White Sands, and the Army's activities at Cape Canaveral, plus its control of all Army missile procurement. Ordnance Guided Missile School, which is graduating nearly 5,000 missileers this year, will graduate double that number next year.

More on money! Somebody figured out that AF BMD is spending on ballistic missiles at the rate of $30 a second, 24 hours a day, 365 days a year. And while we're at it, this page looked up Argus in the dictionary and found that it's a mythical monster "with a human shape but with 100 eyes" . . . Just for the record, ARPA has budgeted $15-million for Project Argus in fiscal year 1959. And of the $72-million listed for "other advanced research", ARPA schedules $20-million for ABMA/JPL; $7-million for AFBMD; $3-million for NOTS; and $44.7-million for follow-up programs . . . which may point the way the wind blows for Army et al.

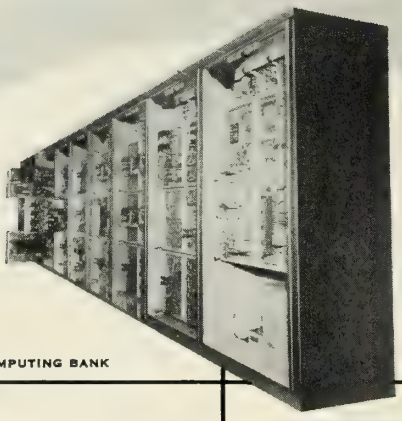
S.H.

FROM CIRCUITS TO CONSOLES
FROM BREADBOARD TO TACTICAL

ERCO has built electronic and electro-mechanical devices on a production basis — from subminiature transistorized servo amplifiers to complete computers for permanent installation or ruggedized for use in mobile units of all types.

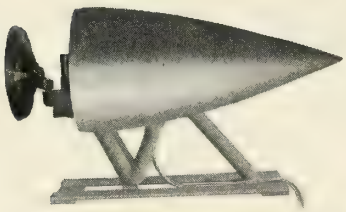
We can work to your specifications and we can supply the design and production engineering to further assist you.

No matter what your requirements are, we can help you. Send today for your brochure . . . "ERCO Production Facilities" . . . for a more comprehensive picture of our abilities.

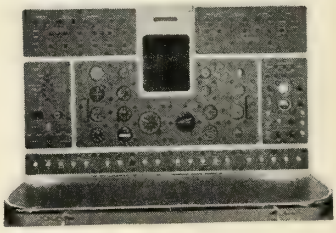


ELECTRONIC COMPUTING BANK

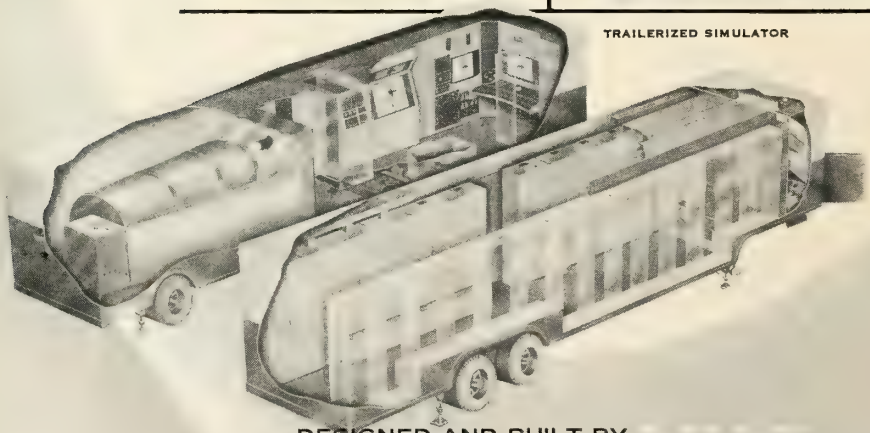
RADAR ANTENNA



TYPICAL CONSOLE



TRAILERIZED SIMULATOR



DESIGNED AND BUILT BY

NUCLEAR PRODUCTS - ERCO DIVISION, ACF INDUSTRIES INC., RIVERDALE, MARYLAND

AMERICAN CAR AND FOUNDRY • AVION • CARTER CARBURETOR • SHIPPERS' CAR LINE • W-K-M • ADVANCED PRODUCTS

Heat Control

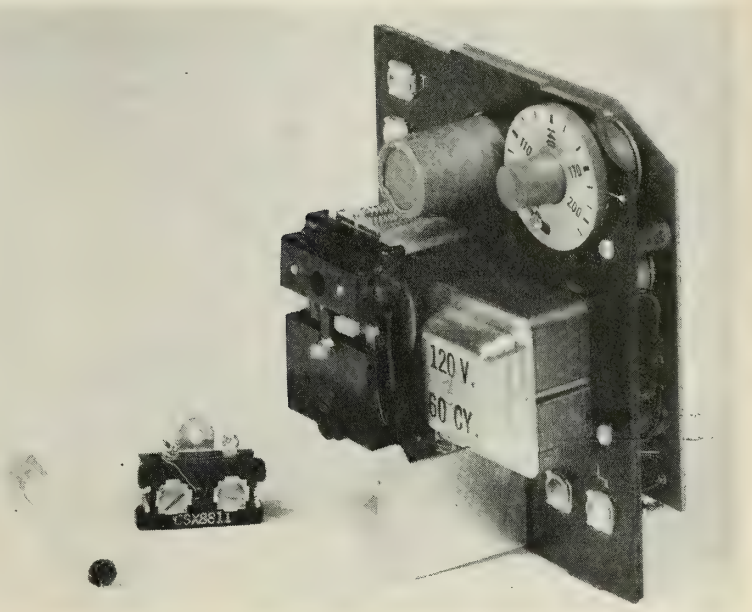
Transistorized Unit Is Versatile

A transistorized amplifier relay system for remote control of temperatures has been introduced by Minneapolis-Honeywell Regulator Co. The company describes it as the world's most versatile temperature controller.

The system consists of a compact transistorized amplifier which serves as the temperature controller, and a vibration-proof mounting containing a thermistor which acts as the sensing element. The thermistor mounting and amplifier relay can be located as much as two miles apart.

Mountings for the thermistors are available in sizes and shapes to fit any application. They can be as small as $\frac{3}{32}$" in diameter and 2" long. The company claims that the mountings can withstand blows from a hammer without damages to the sensing element.

The system may be used to control air, surface or immersion temperatures. Amplifier relays are available in eight overlapping ranges of approximately 100°F to permit control from −60°F to 520°F. Control point is very stable, with shift of less than one degree for every 70-degree change in ambient temperature. One relay can be used with a variety of heat sensing units.



The amplifier relay can be either surface or flush-mounted, using a special box which is 5" x 7" x 2⅞". Wiring between sensing element and relay need not be shielded since the bridge circuit is dc powered and presents no capacity balance problem. The amplifier relay has a resistive load rating of 1,500 watts at 240 volts.

Circle No. 230 on Subscriber Service Card.

Inertia Switch Operates On Unique Basis

Miniature, and lightweight inertia switches that reportedly operate on a new principle, and require only one moving part, have been introduced by Safe Lighting, Inc. The principle of operation may be determined from the components of the reset type switch.

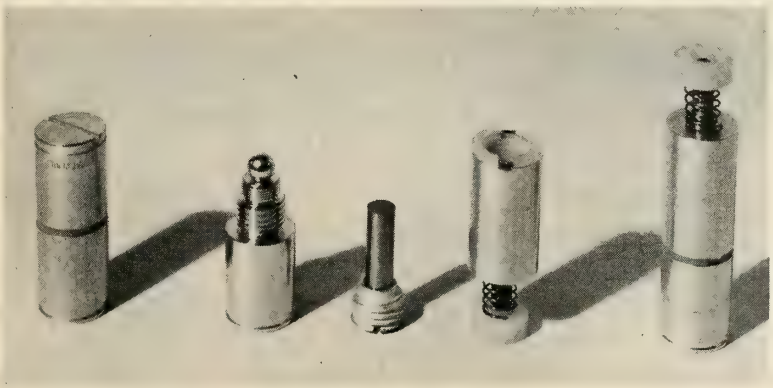
The switch body and a precision ground ball rest in an inverted cone. The Alnico magnet-screw assembly is threaded into the switch body to provide adjustable magnetic attraction to the steel ball. A reset switch cap, with a nylon insulating bushing and push-button, actuates the reset mechanism.

In the new reset type switch, the cap is made of steel. When the ball rolls outward on the cone and makes contact with the cap, it closes the electrical circuit between body and cap. At the same time, it closes an air gap in the magnetic field, which holds the ball in the closed circuit position until it is opened by the reset button.

In the momentary type switch, the cap is made of brass. In this class of switch, the ball will return to the open position.

Reset type switches can be used as one-shot closing devices without the use of a relay, or as memories indicating that a specific acceleration or shock level has been exceeded. Momentary type switches can be used with latching relays for many purposes, or in conjunction with counters to provide statistical counts.

Twenty-four standard models of the two classes of switches provide acceleration levels from .15 to 20 G's.



Circle No. 240 on Subscriber Service Card.

Motor-Alternator Set Serves Ground Equipment

A high performance motor alternator set designed to meet requirements for ground power, test and missile

← Circle No. 80 on Subscriber Service Card.

ground checkout equipment has been developed by General Electric. With its associated control, the set is capable of converting either variable voltage dc or variable voltage and frequency ac to closely controlled constant voltage and frequency ac.

According to the company, the set is designed for 5,000 hours continuous duty with only normal brush maintenance. The unit is usable as a power supply for laboratory test equipment, because it can operate from fluctuating inputs.

A dc drive motor makes it possible to hold the output speed and frequency nearly constant by controlling the motor with a static buck-boost field control. When input voltages are ac, rectifiers are used to supply dc voltage to the drive motor.

Accurate regulation of output voltage is performed by a static field control device coupled with the alternator field. This system incorporates a field control rheostat which permits selection of the nominal regulated output voltage. Plus or minus 7½% adjustment is possible.

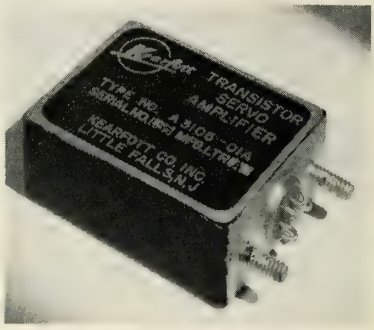
The new high performance motor alternator set is about 8½" in diameter and 25" long. It weighs about 230 lbs., including rectifiers and necessary control mechanisms.

Circle No. 235 on Subscriber Service Card.

Small Servo Amplifier Entirely Transistorized

Kearfott Co., Inc. has developed a miniature, completely transistorized servo amplifier, that can deliver a maximum power of 2.5 watts, and drive Kearfott motors R119-5 or R124-5.

The unit is shock and vibration resistant, and suited to missile applications. The amplifier may be readily mounted inside individual servo cans along with other components of the servo with which it is associated. The amplifier is completely potted in its case, with a special potting compound having high strength, stability, and lightweight characteristics.



Gain of the amplifier may be easily established at various values between 150 and 1,000 merely by inserting one external resistor to achieve the gain desired. Should it be necessary to interchange one unit for another, gain tolerance between inter-changed units will not exceed ±12%.

Weighing only 1½ ounces, the amplifier measures 1½" x 1⅛" x 9/16", and operates through a chassis operating temperature range of −55°C to 110°C. Throughout that temperature range, gain stability is within ±2.5 db, power gain is 62 db, and voltage gain is adjustable between 43.5 db to 58 db by means of an input resistor.

Circle No. 234 on Subscriber Service Card.

Direct-Reading Knob Eliminates Errors

A knob that eliminates reading errors by single scale read-out and low ambiguity has been produced by Circuit Instruments Inc.

This direct reading, three-digit, turn-

BINKLEY LEVELING JACK

Has 100,000 lb. capacity . . . Manually lifts 18 tons



Introducing Binkley Manufacturing Company, an important new supplier of components for ground support and handling equipment. This new leveling jack, for example, was custom designed by Binkley engineers for the Food Machinery and Chemical Corporation, San Jose, California. It has a 100,000 lb. capacity and is used to manually lift and level weights up to 18 tons. This is accomplished through application of the SAGINAW BALL BEARING SCREW, a General Motors product with 90% efficiency. Actually requires only 1/5 as much torque as a conventional Acme screw.

Binkley serves the individual requirements of a growing list of ground equipment builders.

Perhaps you, too, have a ground handling equipment problem. If so, why not take it to the specialists at Binkley for a solution. A skilled engineering team will devote prompt and confidential attention to the design, development and fabrication of specialized equipment for your needs.



Binkley

MANUFACTURING CO.
Warrenton, Missouri

Circle No. 129 on Subscriber Service Card.

Note—Commercial and Military Packaging Engineers:

LINK-LOCK

...is the rugged answer to your exacting container closure problems

LINK-LOCK plays an important role in the design of this container

Simmons' LINK-LOCK provides pressure-tight, impact-resistant closure, plus quick closing and opening, on this reinforced fibrous plastic product made by the new automatic pre-form process developed by Pressurform Container Corp. The two-section container will be used by the Light Military Electronic Equipment Dept. of General Electric Company for shipping airborne radar jamming units to the Air Force.

Of prime importance are the container's lightness, strength, rust- and mildew-resistance, ability to withstand high pressures without distortion, ease of locking and opening, and low cost.

Here's why LINK-LOCK is ideal for use on military cases produced to exacting specifications as well as on inexpensive commercial containers:

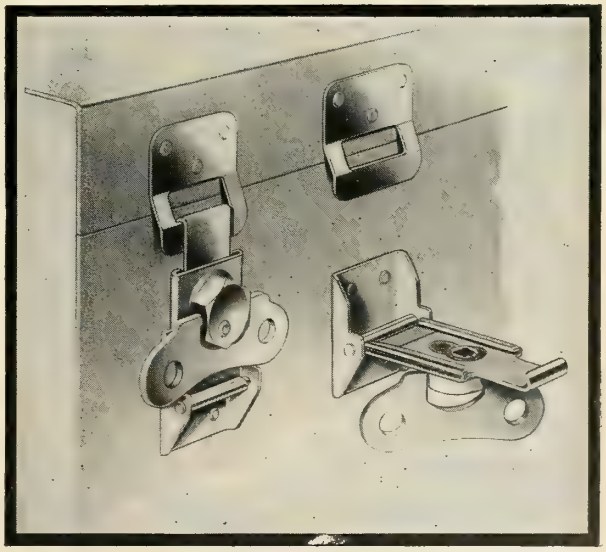
- High closing pressure with light operating torque... insures pressure-tight seals where required.
- Impact and shock resistant (positive-locking).
- Compact design...lays flat against case even when unlocked.
- Available in 3 sizes, for heavy, medium, and light duty.
- Opening and closing by wing-nut, screwhead, or hex nut.
- Flexible engagement latch design...can be varied to suit different conditions.

Also available! Spring-Loaded LINK-LOCK... ideal for less expensive containers where costs won't permit precision production. Spring provides take-up to compensate for set in gasketing, irregularities of sealing surfaces, and mounting inaccuracies.

Where does the versatile Simmons LINK-LOCK belong in your design? For full information and specifications, send for LINK-LOCK DATA SHEETS today. Samples and engineering service available upon request.



Courtesy of Pressurform Container Corp., and the LMEE Dept. of General Electric Co.



SIMMONS
FASTENER CORPORATION

1791 North Broadway, Albany 1, New York

QUICK-LOCK SPRING-LOCK ROTO-LOCK LINK-LOCK DUAL-LOCK

See our 8 Page Catalog in Sweet's 1958 Product Design File

Circle No. 79 on Subscriber Service Card.

indicating knob is used to position any multi-turn device of ten turns or less. Attached directly to a precision potentiometer, it will accurately read the position of the device directly to within a hundredth of a turn.

Made as a companion to Circuit Instruments' line of precision potentiometers, it can be directly mounted on any device with a ¼" shaft.

Fingertip turn of the brake screw locks the dial at its setting. The knob requires only a 3/32" hole on the panel for locating the pin, and is attached by set-screw directly to the shaft of the potentiometer.

The knob is available in black or clear anodized aluminum with black numerals.

Circle No. 242 on Subscriber Service Card.

Test Table Developed for Missile Components

Ideal-Aerosmith, Inc. is manufacturing a new azimuth, rock and tilt test table for pre-testing of missile components. The motion table is ground equipment to simulate the attitudes of flight.

Moving parts are entirely housed, and consist of motor, gear train and levers to provide an angular motion in the azimuth, rock and titlt axes simultaneously. The rock and tilt motion provides a 15° included angle . . . the azimuth motion providing an included angle of 15°, plus or minus 1°.

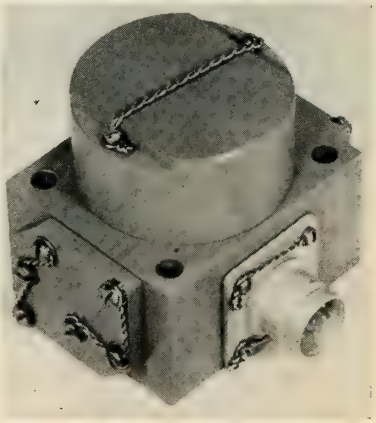
The quick-acting manual adjustment brings the table surface to a level position in a given azimuth with .1° in all axes, by action of a micro switch and preset stops or dogs.

The table can be adapted to remote control . . . the duty cycle is continuous operation . . . and the modular design provides that all major components, such as motors, relays and components boards, as well as functional modules can be installed or replaced using solderless connections.

Circle No. 248 on Subscriber Service Card.

Compact Servo Valves Feature Missile Needs

Lightweight, compact electro-hydraulic servo valves, designed to meet the requirements of missile hydraulic servo systems, are available from Pesco



Products Division, Borg-Warner Corp.

The valve design is said to feature fast response, low internal friction, minimum null shift, faithful reproduction of small input signals and insensitivity to variations intemperature and load or supply pressures.

The servo valve is a proportional flow control unit. According to the company, it operates on a dynamic continuous flow sensing principle, made possible by a unique flowmeter design.

Output flow of hydraulic fluid is linearly proportional to the amplitude of the electrical differential input signal. Flow-type feedback control in the



unit permits relatively large power spool overlap, allowing larger spool clearances and reducing costs.

This design configuration produces a high fidelity valve with dead zone held to an absolute minimum. Gain in the valve is constant despite variations in load and supply pressures.

Servo valves are available for rated flow capacities from ½ gpm to 7 gpm, and can be designed for use with any required system pressure 500 psi or higher.

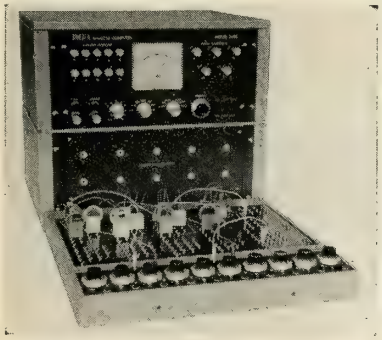
Circle No. 238 on Subscriber Service Card.

Desk-Top Size Computer Developed for Research

Donner Scientific Co. is marketing a new desk-top size, high-accuracy analog computer for engineering analysis and research. The new Model 3400 computer offers 0.1% performance with chopper stabilized printed circuit amplifiers.

A typical computer contains 10 amplifiers, five initial condition power supplies, and supporting control and metering circuitry. Performance of the 3400 series compares favorably with that of larger computer consoles.

Among the key features of the Model 3400 are: positive and negative reference voltage available at problem



board; removable problem board with expanded jack field; repetitive or continuous operation for scaled and real time solutions; simultaneous control of multiple computer arrangements from any one computer or from remote station; individual overload indicators and amplifier balance controls; operation from 115/230 volts (±10%), 50-60 cps power.

Specifications for the chopper stabilized amplifiers are: dc gain in excess of 50 million; maximum offset of a unity inverter, less than 200 microvolts/day; drift of a unity integrator, less than 100 microvolts/second; phase shift of a unity inverter, less than 0.50 at one kc.

Circle No. 232 on Subscriber Service Card.

Tape Recorder/Reproducer Offers Range of Speeds

A digital magnetic-tape recorder/reproducer is now available from Consolidated Electrodynamics Corp. The instrument provides users with a wide range of standard tape speeds and tape widths.

Standard speeds range from 7½ to 100 ips. Two low speeds (0.4 and 0.8 ips) and a high speed of 150 ips are also available from this manufacturer.

Tape widths are ¼", ½", ¾", and 1". Start and stop times are less than three milliseconds with a guaranteed accuracy of 0.05" in both forward and reverse directions.

Digital recording inputs can be accepted from such sources as analog-to-digital converters, storage registers, punched paper tapes, punched cards and tape readers. The readout of the digital magnetic tapes may be used to feed digital computers, card punches,

SPIN THAT CONE!

PHOENIX
Spin-Fab
PROCESS

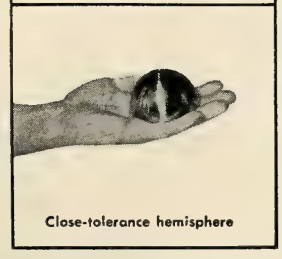
The fast, low-cost way to produce spherical shapes accurately.



World's Largest Spinning Lathe at Phoenix Products Co.



Nose and aft sections, Phoenix fabricated



Close-tolerance hemisphere

Diameters up to 15 feet can be spun by PHOENIX . . . from any metal that can be worked . . . in thicknesses up to ¾" aluminum.

Difficult shapes a specialty. Complete fabrication including deep-drawing and assembly also available in large modern plant with finest facilities in the industry.

Our engineers have long experience in manufacturing of components for missile, rocket and aviation development and production.

New "Phoenix Spinning Manual" just off the press. Copies and other research data on request. Write



PHOENIX PRODUCTS COMPANY
4701 N. 27th St., Milwaukee 9, Wis.

Circle No. 131 on Subscriber Service Card.

LINK YOUR CAREER TO TOMORROW

we speak

your language

at Link



Circle No. 81 on Subscriber Service Card.

Sure, there's a lot of dreaming still to be done in electronics! But there's an awful lot that needs *doing*. Link Aviation, Inc., pioneer of flight simulation, is now operating fine new laboratories at Binghamton, New York and Palo Alto, California, for that very purpose... to put electronics to work at new exciting jobs. A selected number of engineers are needed at this time.

There are many reasons why Link chose these communities for their laboratories.

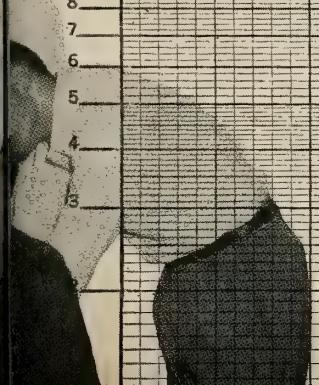
You can settle down and raise a family. And, if you intend to continue advanced technical study, you can benefit from the Honors Cooperative Program that provides advanced study, under regular University curriculum, during working hours with all tuition expenses paid by Link. The engineers Link selects will not be the type who have mere "competency" as their standard. Nor will they be the ivory-tower genius type (though some works of genius may be expected). What Link needs is men who will carry projects through from concept to development. In addition to providing you with a comfortable physical climate in which to live, an ideal mental climate in which to work, and an enviable academic climate in which to advance your studies, Link furnishes you with all those employee benefits you associate with the most advanced management practice. Fine pay. Good vacations. Generous hospital, health and retirement benefits. Link is right in believing "we speak your language" because management men are engineers. They understand your work and point of view. This kind of administration provides engineering thinking right up to policy level. If this stimulating climate appeals to you...

Write:
Mr. Ken Viall
Link Aviation, Inc., Dept. X-4
Binghamton, New York
Or:
Mr. Joe Larko
Link Aviation, Inc., Dept. X-4
P.O. Box 1313
Palo Alto, California

LINK

GENERAL PRECISION EQUIPMENT CORPORATION GPE

LINK AVIATION, INC.
Binghamton,
New York



LIGHTER!

STRONGER!

BRIGHTER, more attractive appearance

Another typical example of how

Hunter Douglas Aluminum Cold Forgings

improve product performance and saleability

This general purpose "WIG-O-FLEX" flexible coupling, manufactured by E. B. Wiggins Oil Tool Co., Inc., Los Angeles, is widely used in the aircraft industry for fuel lines, as well as air, oil and occasionally hydraulics. It operates over an ambient temperature range of −65°F to +450°F, usually within a 125 psi maximum operating pressure.

Formerly a permanent mold casting of 356 T-6 aluminum alloy, an alert engineering department saw product improvement possibilities by cold forging without increasing cost.

Hollow, closed-end blanks are now cold forged from 2014 T-6 aluminum alloy. Parts are subsequently finished using high-production "chuckers." The final advantages resulting from cold forging are as follows:

STRENGTH—Approximately 3 times greater than before.

WEIGHT REDUCTION—⅓ less weight than former coupling. Increased material strength permits thinner walls. Wall thickness now limited only by mechanical problems of turning and knurling.

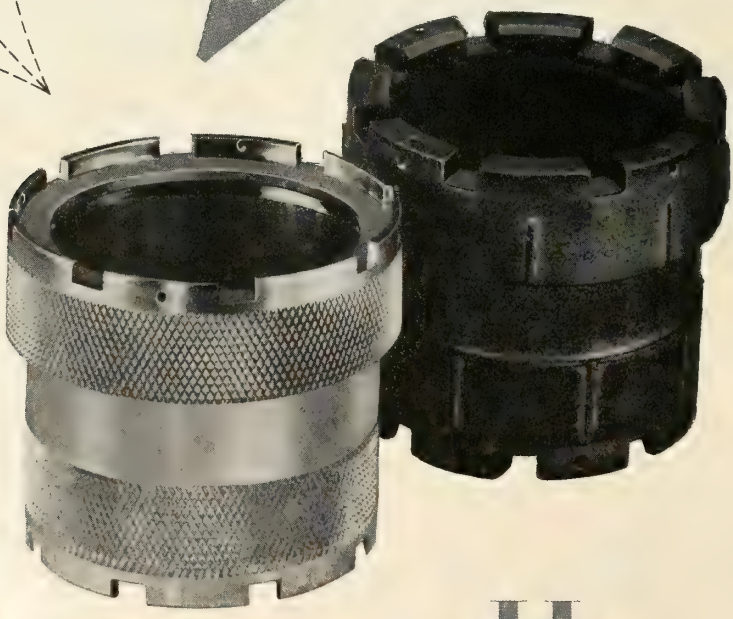
HIGH SAFETY FACTOR—Operating pressure is 125 psi. Pressure tests actually exceed 850 psi.

IMPROVED APPEARANCE—Bright finish, uniform knurling and color anodizing has vastly improved eye appeal.

ECONOMY—All advantages gained with *no* increase in selling price.

If your components can benefit by high strength, precision tolerances, no porosity, no draft and improved surface finishes investigate Hunter Douglas Aluminum Cold Forgings!

FREE BOOKLET: A comprehensive treatise on cold forging is available to letterhead requests.
Write for the "Story of Aluminum Cold Forgings."



Hunter Douglas Aluminum

DIVISION OF BRIDGEPORT BRASS COMPANY • Dept. MR-6 3016 Kansas Avenue, Riverside, California

Circle No. 172 on Subscriber Service Card.

billing machines, plotters, machine tool program control units and data printers.

Typical of the 5-680 series is the continuous operation (16-hour day, 5 day week) with a minimum operational life of 5,000 hours without a major overhaul.

The new series features built-in end-of-tape sensing, all-metal surface magnetic heads, and low-flutter characteristics. Fast forward and rewind speeds (250 ips, nominal) results in rewind time of three minutes for a full 10½″ reel.

Circle No. 241 on Subscriber Service Card.

Insulator Mount Possible For Transistors, Diodes

New stud-type copper-and-ceramic insulator mounts for diode, rectifiers and transistors have been developed by Thermo Materials, Inc.

The insulator mounts, rated up to 4,000 volts, are designed for high altitude operation and to allow highly efficient heat transfer to the chassis or ground. In overall thermal drop the mounts are rated better than 1°C per watt.

Physically, the mounts consist of a copper alloy cylindrical heat sink, copper alloy flange and ceramic insulator brazed together into a unit. A copper alloy mounting screw is supplied in two thread sizes; the threaded mounting bore in the heat sink is available in four thread sizes.

Circle No. 231 on Subscriber Service Card.

Power Supply Provides Variable Voltages

Spellman Television Co. has introduced its model LAB-90, a high voltage regulated dc power supply with voltages continuously variable from 0 to 90 kv. Output current is at 1 ma. at 80 kv; 2 ma. from 40 kv down.

Voltage regulations are better than 1% throughout the range. Panel dimensions: 19″ wide, 26″ high & 18″ deep. Available complete with HV meter in either positive or negative polarity output.

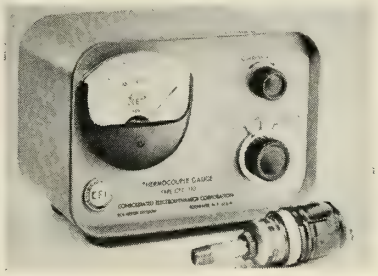
Circle No. 247 on Subscriber Service Card.

Thermocouple Gauge Now Battery-Operated

A single-station, battery-operated thermocouple vacuum gauge designated Type GTC-110 is available from the Rochester Division of Consolidated Electrodynamics Corp. Powered by a 1.5 volt size "D" flashlight battery, contained in the gauge housing, the GTC-110 covers the range from 0 to 1000 microns Hg on one non-linear scale, with 5 microns the smallest indicated marking.

Recalibration is accomplished without a reference gauge by setting the indicator at zero when the pressure in the system is below 1 micron.

Provision is made for checking the heater current setting by means of a potentiometer knob on the front of the



gauge. The compact cabinet-mounted gauge is operable as a moderately sensitive leak detector throughout its range.

The all-metal TG-77 sensing tube is rugged, inexpensive and not harmed by exposure to atmosphere.

Zero drift, in this particular product, has been reduced by using a lower heater current to decrease the rate of thermal decomposition of organic vapors with the tube.

The GTC-110 gauge is 4 7/8″ high, 6½″ wide, 3¾″ deep and weighs 4½ lbs.

Circle No. 237 on Subscriber Service Card.

Tungsten Carbide Coating Has Extreme Hardness

A tungsten carbide material that provides a working surface hardness of approximately 98 Rockwell A is being marketed by Walmet Corp. under the trade name of Spra-Carb.

According to Walmet, the coating is an extremely hard tough layer of tungsten carbide particles bonded with nickel, chromium and boron alloy. The binder alloy imparts properties for toughness and strength, as well as bonding to the base metal. The carbide also contributes to the high wear resistance.

In machining, the coating can be worked with a good hard grade of tungsten carbide. In grinding, a green silicone wheel may be used for rough or finish grinding if suitable grit wheels are used.

About 0.010″ extra stock is sprayed on the product for finishing purposes to provide a range of thickness of 0.010″ minimum to 0.062″ maximum after grinding or finishing.

Circle No. 254 on Subscriber Service Card.

Narrow Passband Filters Feature Miniature Size

High selectivity, stability and subminiature size are reported to be combined in the new Bulova Type 2E2SM6 narrow passband filters, manufactured by the Electronics Division, Bulova Watch Co. Operating in the frequency



Serving the Missiles Market

with the world's newest and most modern Passenger and Cargo aircraft, radar equipped, of course.

FLY NATIONAL

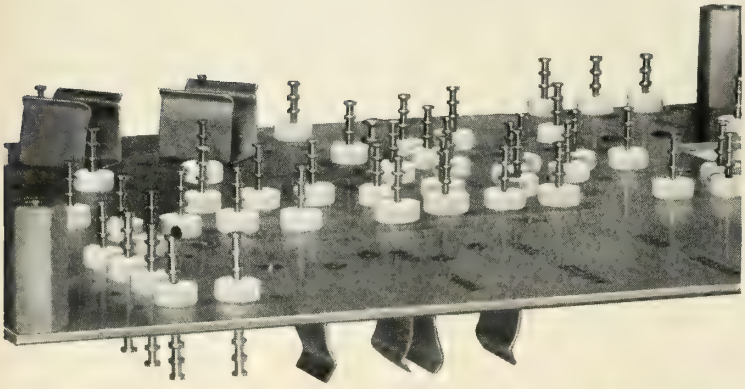
AIRLINE OF THE STARS

☆ IN MISSILE GUIDANCE
☆ IN TRACKING SYSTEMS
☆ IN FIRE CONTROL
☆ IN AIRBORNE RADIO
☆ IN COMPUTERS
☆ IN RADAR

where it counts, it's

Chemelec®

STAND-OFF & FEED-THRU INSULATORS

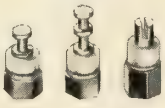


Withstanding shock, vibration, temperature extremes, Chemelec Insulators—made of du Pont TEFLON—are replacing components of brittle materials for *high reliability* in many critical electronic circuits.



COMPRESSION MOUNTED TYPE

Made in both compression-mounting and metal base, miniature and subminiature types, in standard R.M.A. colors and wide range of sizes and terminal designs.



METAL BASE TYPE

Write for new catalog No. 358. FLUOROCARBON PRODUCTS, INC., division of United States Gasket Co., Camden 1, New Jersey.



PATENTED

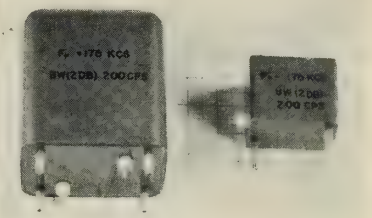
Fluorocarbon Products Inc.

Circle No. 132 on Subscriber Service Card.

. . . new products

range of 175 to 300 kc, they are said to be the smallest filters available that offer such steep rejection slopes.

In bandwidths from 20 cps to over 1 kc, the filters can be made with a



shape factor (60/6 db) of 3.5 to 1. Insertion loss (dependent upon bandwidth) can be as low as 1 db, while the ripple in the passband is less than 1 db. Drift is less than 10 cycles over the temperature range of 0°C to 75°C.

Circle No. 233 on Subscriber Service Card.

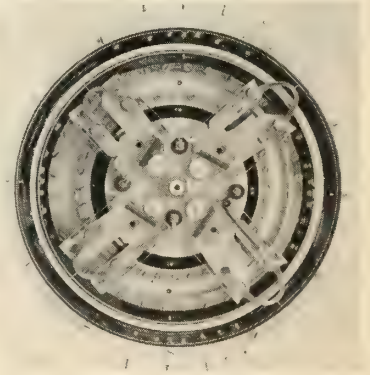
Precision Potentiometer Claimed Most Accurate

British Radio Electronics Ltd. is marketing the Colvern precision sine/cosine potentiometer No. 9600, for which the company claims a law accuracy of ±0.05% peak to peak.

The machined light-alloy case is fitted with resistance elements wound on shaped cards, each card covering 1800; pairs of cards being joined with metal bridges to give 360° of track.

Center taps of the potentiometer are on a single turn of wire and one or two pairs of concentric cards can be fitted, each carrying two brushes to give either one sine and cosine or two separate sine and cosine outputs.

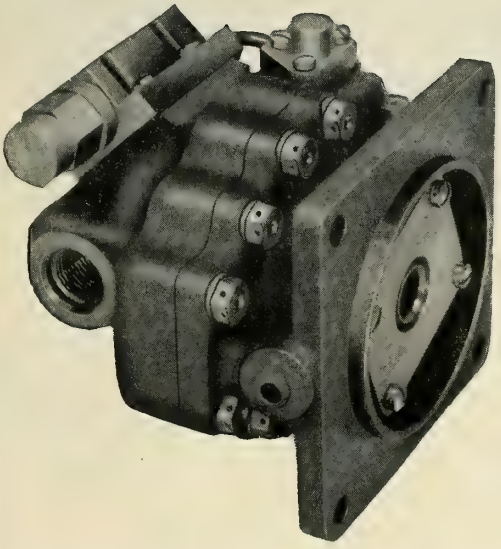
Resistance range of the unit is 12,500 to 50,000 ohms, and the resistance

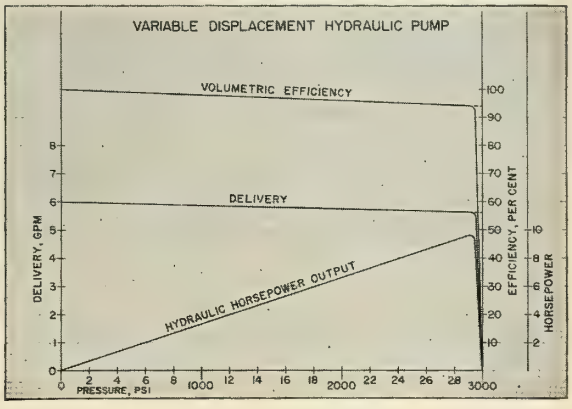


tolerance is ±5%. Dissipation is 5 watts, maximum working voltage 1000 vdc and maximum starting torque is 25 oz./in.

Life expectancy of the series 9600 potentiometer is dependent on the con-

New Hydraulic Pump for 550° F and 12,000 RPM Service





Sizes and capacities designed to meet your requirements

This new Sundstrand hydraulic pump successfully meets the need for a lightweight, compact unit capable of operating at elevated temperatures with high reliability. Note that it is rated for service to 550° F *inlet oil*, as well as ambient temperature.

In addition to the .125 cu. in pump illustrated, other sizes will be available as required.

The new pump is a result of a continuing Sundstrand program which is crossing previous temperature barriers for hydraulic components. Inquiries on requirements in high-temperature areas are invited.

Mail coupon for complete technical data on the new Sundstrand pump for high-temperature service.

Characteristics of Pump Illustrated

- **Flow: 6 gpm**
- **Speed: 12,000 rpm rated, overspeed to 18,000 rpm, rapid acceleration.**
- **Temp. Range: —65° F to 550° F *inlet* and ambient.**
- **Inlet Pressure: 60 psig.**
- **Discharge Pressure: 3000 psig.**
- **Cutoff: Maximum full flow pressure to zero flow pressure within 50 psi.**
- **Displacement: 0.125 cu/in. rev.**
- **Weight: 5.0 lb.**
- **Size: 4.344" over-all length, 4.452" over-all width.**
- **Lubricant or Fluid: Any of those common to aircraft applications.**
- **Volumetric Efficiency: 94% at rated speed and pressure.**
- **Mil Specs: Characteristics conform to MIL-P-7740B Type IV System.**

Sundstrand Aviation
2417 Eleventh St., Rockford, Ill.

Please send data on pump for 550° service.

Name_____

Title_____

Company_____

Address_____

City_____ State_____

☐ Immediate ☐ Reference

SUNDSTRAND AVIATION

Division of Sundstrand Machine Tool Company, Rockford, Illinois
Sundstrand Turbo, Denver, Colo. • Western District Office: Hawthorne, Cal.



CEC Transfer Line installation shows temperature of outside pipe only 2°F. different from ambient.

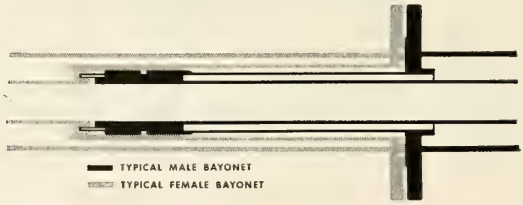
Pipe carries liquid O_2 continuously...why no frost?

This is a pipe within a pipe... with a vacuum in between. Like a Thermos bottle.

Heat transfer from pipe to pipe is only 3 BTU/ft./hr.

Compare this with 186 BTU/ft./hr. for pipe insulated with fiberglass, foamglass, cork, etc.—with 290 for asbestos-insulated pipe—with 340 for pipe insulated with ⅛" frost—and with 600 and above for noninsulated pipe, and you see why CEC vacuum-jacketed transfer lines are ideal for moving liquid rocket and missile fuels.

And the *entire* system is vacuum-tight. Heat transfer is very low even at the joints and flanges, again shown by the absence of frost.



This special bayonet joint, developed by CEC, gives complete and permanent sealing between sections of transfer line. Notice the O-ring groove in the male bayonet and the capturing flange in the female side. The O-ring can never leave the flange. Flanges are machined to a 63 micro-inch finish.

A complete CEC transfer system includes the transfer lines, available in lengths up to 40 feet in various diameters to meet customer specifications; vacuum pumps; gauges; vacuum-jacketed valves; baffles; traps; and leak detectors.

For complete information contact the nearest CEC sales office. Complete engineering assistance in the field is available.

For preliminary details, write for Bulletin 4-80.

Consolidated Electrodynamics

Rochester Division, Rochester 3, N.Y.

SALES AND SERVICE OFFICES IN PRINCIPAL CITIES

Circle No. 133 on Subscriber Service Card.

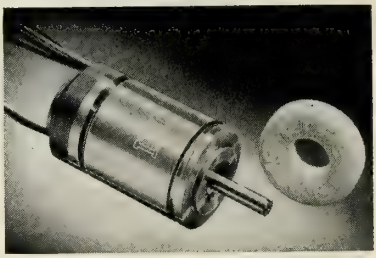
ditions of use, but at speeds of 30 rpm, a life on the order of 500,000 revolutions can be expected. The company maintains that the unit is the most accurate sine/cosine potentiometer available as a production item.

Circle No. 255 on Subscriber Service Card.

Indication and Control Devices Available

A series of synchros, resolvers and linear transformers for indication and control have been developed by Induction Motors of Calif., a division of Induction Motors Corp. The new units are for 26v and 115v, 400 cps operation. Stainless steel construction with high nickel laminations provides for corrosion resistance. Operating temperatures are from −50°C. to +125°C.

The size 8 Synchro is used to actuate a pointer to reproduce angular data at remote points, such as in trim flap and similar control surface applications. According to the company, in addition to position-indicating on valves, computer shafts and missile components,



the units achieve extreme accuracy as sensing elements and in servo mechanisms.

The weight of the synchros is 44 grams. Length of the size 8 is 1¼" and diameter is ¾".

Circle No. 236 on Subscriber Service Card.

Screw Locking Inserts Provide Sustained Torque

Groov-Pin Corp. has introduced a new NYLOK Series of self-tapping, screw-locking Tap-Lok Inserts. The nylon pellet imbedded in the insert provides a sustained locking torque to the fastening screw and at the same time provides a seal both to the internal and external threads of the insert.

The Nylon resists heat, cold, moisture and most commercial solvents according to the manufacturers. The inserts are applicable for military and civilian use, in aluminum, magnesium and other structural materials where a securely locked and stronger threaded connection is essential.

Available in cadmium plated case-hardened steel and stainless steel—



Wider variety of alloys than ever before now available for castings from Standard

From Standard, you can now enjoy the same superior, personalized service—and rapid delivery—on alloy steel castings as you have enjoyed in the past on carbon steel castings.

Our newly expanded facilities—including installation of a newest design electric furnace—make it possible for us to give you even more complete service than ever before.

We invite you to discuss your next casting needs with us. You will appreciate our personal interest in your problems—and our economical methods of solving them. Write Dept. 6-F.

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Giannini
PRESSURE TRANSDUCERS
for any airborne application

These instruments are typical of the extensive Giannini line of presssure transducers:

COMPACT-LIGHTWEIGHT



451218 "CUBIC INCH"

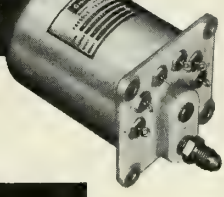
SIZE: One inch cube

WEIGHT: 2 ounces

RESOLUTION: to 300 wires (0.33%)

RANGE: 0-15 to 0-50 psi (a, d or g)

HIGH ACCURACY-RESOLUTION



451212 HIGH LEVEL OUTPUT

ACCURACY: 1% of reading for most applications (considering linearity, hysteresis and repeatability)

RESOLUTION: 2000 wires (0.05%)

RANGE: 0-10 to 0-50 psi (a, d or g)

LOW PRESSURE



45154 HIGH VIBRATION

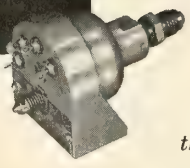
VIBRATION: 25g to 2000 cps

REPEATABILITY: 0.8%

RESOLUTION: to 250 wires (0.4%)

RANGE: 0-10, 0-15, 0-20 psi (a, d or g)

HIGH PRESSURE



461227 BOURDON TUBE

VIBRATION: 36 g to 2000 cps for special applications

RESOLUTION: to 400 wires (0.25%)

RANGE: 200-10,000 psi (a, d or g).

Detailed Bulletins are available on these transducers...write for them today.

Giannini measures & controls:

ω β θ $\dot{\zeta}$ τ ν ϕ

δ Ω_s a_s h P ΔP T

T_S P_S Q_C M T_0 P_T TAS

PRECISION INSTRUMENTS AND CONTROLS

Giannini

G. M. GIANNINI & CO., INC., 918 EAST GREEN STREET, PASADENA, CALIF.

Circle No. 134 on Subscriber Service Card.

. . . new products

in regular and medium lengths. Inserts won't strip—will withstand severest vibration without loosening and meet all torque requirements of MIL N-25027 (ASG).

Circle No. 256 on Subscriber Service Card.

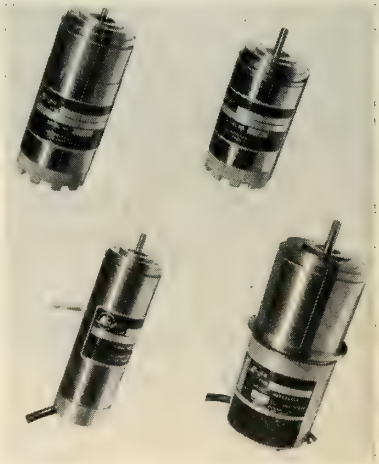
Precision Tachometer For Math Integration

A variety of servo motortachometers, produced by Kearfott, Co., Inc., will find application as integrators in mathematical computations demanding accuracies on the order of .01%.

Ranging from Size 11 (1.062" diameter) to Size 20 (1.950" diameter), these components exhibit a high degree of output voltage linearity, no frequency change between input and output voltages, stable output voltages over the temperature range specified, and extremely low harmonic distortion.

Typical linearities of output voltages range from .03% to .10%. Compensating networks are also available from the company.

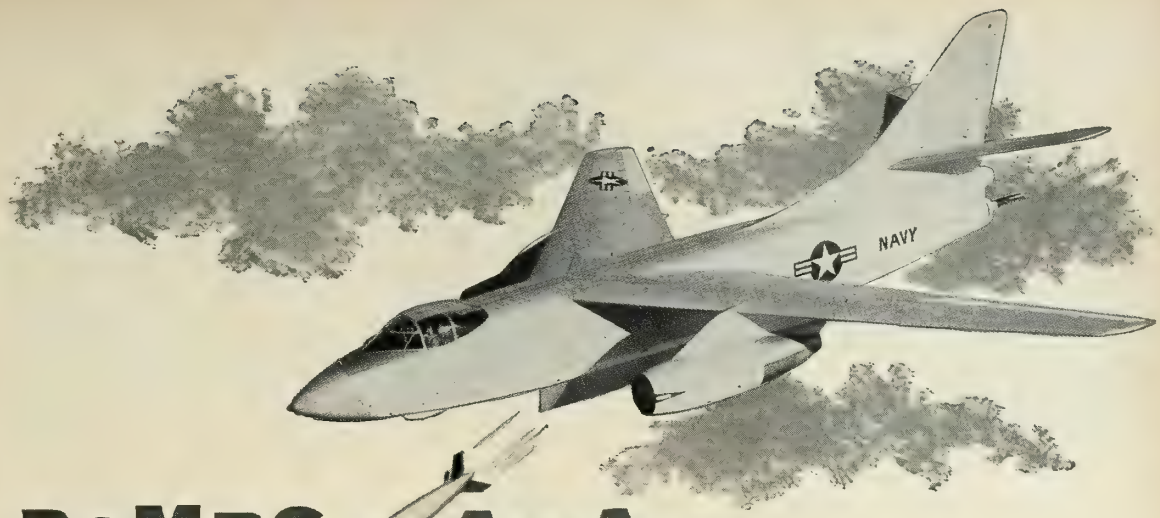
To reduce error caused by output variations due to temperature, either



of two methods is employed in these units. Temperature is controlled by thermostatic or mag-amp means, or temperature compensation through use of integral thermistor-resistor network's used, so no warmup time is required before operation.

Temperature-compensated tachometers do not need auxiliary power or equipment for heating. In certain special applications, heating and compensation are combined in a single unit to provide accuracy over wide ambient temperature ranges, without employing an accurate heater control device such as a precision thermostat or mag-amp.

Circle No. 239 on Subscriber Service Card.



BOMBS AWAY...

with the help of heat-treated TITANIUM ALLOY

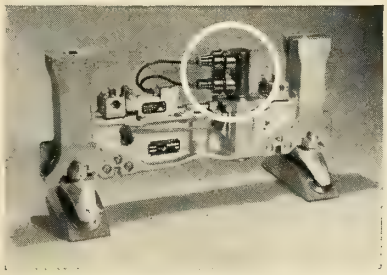
On high speed military planes, such as the Douglas A3D-2 Skywarrior and other jet aircraft, the bomb ejector rack is a complicated and critical mechanism. Any failure might endanger both airplane and pilot.

Three basic parts make up the ejector . . . cylinder, piston and breech. The latter presented the greatest design problem, due to its multitude of functions and irregular shape. Similar breeches made from stainless steel frequently heat-checked and failed, during test firing or hydrostatic testing.

Experience and design calculations suggested that 6Al-4V titanium alloy, produced by Mallory-Sharon, was the metal most likely to meet the exacting requirements.

Actual firing tests confirmed the advantages of titanium for this application. The titanium alloy breech withstood 300 firings before any evidence of heat checking appeared. No failures occurred in firing . . . and the breech withstood hydrostatic pressure of 27,000 psi without failure.

Here's one more example of titanium's outstanding performance in meeting critical design problems. May we help you explore its advantages for *your* product or application? Write for "Titanium Fact File".



Above: Bomb ejector rack, showing forged titanium alloy breech (circled).

Below: Titanium alloy ejector breech, before and after machining.



WHY TITANIUM WAS CHOSEN

1. High strength-to-weight ratio at elevated temperatures for short times.
2. Superior corrosion and erosion resistance.
3. Excellent forgeability.
4. Good machineability in the heat-treated condition.
5. Low susceptibility to hydrogen embrittlement.
6. Good thermal stability.

MALLORY SHARON

MALLORY-SHARON METALS CORPORATION · NILES, OHIO

Integrated producer of Titanium • Zirconium • Special Metals

LIQUID OXYGEN AND NITROGEN TRANSPORT UNITS



Hofman 3000 Gallon Trailer

Built to A.S.M.E. and I.C.C. specifications in sizes from 500 to 3500 gallons. Efficient performance is shown in this Hofman powder in vacuum insulated equipment. Standard features include: bottom fill and discharge line, top fill line, liquid level gauge, vacuum valve and filter, thermocouple vacuum gauge, pressure gauge, A.S.M.E. code stamped inner vessels, quick pressure build-up system, extended stem valves on liquid lines, ending with Hofman quick couplings.



Hofman 500 Gallon Truck

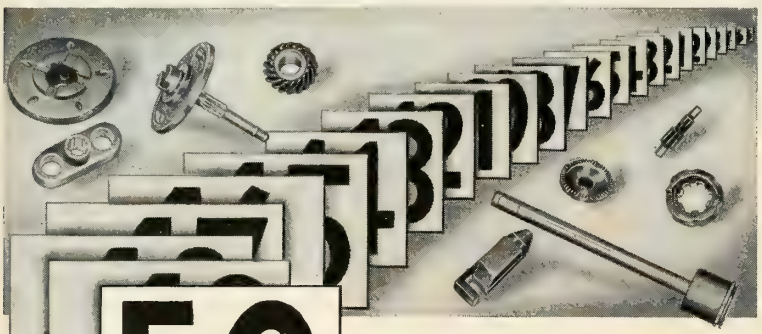
Send for our new 16 page catalog LOW TEMPERATURE APPARATUS

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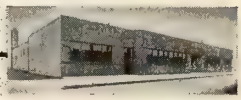


50 YEARS OF EXPERIENCE in the manufacture of SMALL MACHINE PARTS OF HIGHEST PRECISION

The equipment you design and produce demands the finest quality in each of its components. For those machine parts requiring fine finishes, difficult machining operations, and closest tolerances specify LaVezzi and be certain of parts that meet approval. Your quotation requests will receive prompt and careful consideration. Illustrated brochure will be mailed upon request.

LaVezzi MACHINE WORKS

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missile electronics news . . .

Data Processing System Speeds *Thor* Static Tests

A $100,000 electronic data processing system which will automate static testing of the *Thor* intermediate range ballistic missile has been installed at Edwards Rocket Base near Boron, Calif., by the Systems Division of Beckman Instruments, Inc.

The system, ordered by Douglas Aircraft Corp., prime contractor, will speed missile ground tests by automatically recording temperatures, strains and vibrations from up to 350 sources at the rate of five samples per second. It also will alert test engineers the instant any monitored variable exceeds pre-set limits.

The system uses transistors and other semiconductor components instead of vacuum tubes. This enables the unit to record information continuously for extended periods of time without interruption for service.

The electronic unit records test information on perforated paper tape. The tape then is fed into a computer which converts data into form required for engineering study.

Manufacturer Plans Space Lab in Three Years

Northrop Aircraft has detailed its plan for putting a recoverable manned space laboratory into orbit within three years.

The space laboratory, to be used in preparation for U.S. military ventures into space, would be a bullet-shaped capsule, approximately 7 ft. in diameter and 10 ft. long. The passenger would be strapped in a near-reclining position to withstand the forces of acceleration and deceleration. The station would be boosted into an orbit by contemporary rocket engines.

While in orbit, the vehicle would be turned by attitude control jets so that its blunt end faced forward, providing a high drag to slow it as it hurtles back into the atmosphere. It would make several revolutions, and then reverse-thrust rockets would reduce velocity.

The capsule would reenter the atmosphere at a shallow angle which would keep the heating rate and deceleration at acceptable levels.

The blunt end would create high drag and slow the capsule from 25,000 ft. per second to 1,000 ft. per second by the time it reaches a 60,000 ft. altitude. A parachute would be used at a lower altitude for a gentle landing.

Circle No. 136 on Subscriber Service Card.

Amplifying Tube Covers 685-985 mc Frequencies

Tests have been completed on a wide-tuning range 10 kilowatt amplifier klystron, suitable for forward scatter communications and UHF television.

Known as VA-833A, the tube, developed by Varian Associates, delivered more than 10 kilowatts over a 1.4/1 range of frequencies from 685 to 985 megacycles. The tube is being scaled to cover lower frequencies of the UHF TV band and forward scatter portions of the radio spectrum.

During tests, conversion efficiency ranged up to 50%, and power output to 13 kw was reached without apparent strain. Power gain ranged from 40 to 60 db.

The four-cavity amplifier klystron requires about one watt of drive power and needs only addition of dc power supplies, cooling and counting magnet to form a complete microwave amplifier unit. The tube contains all the rf circuitry required to boost the one watt signal to 10 kw.

Four internal cavities tune with individual drive shafts over the full range from 685 to 985 mc. Noncritical klystrons of this type carry a wide band of frequencies composing the whole baseband of some 140 communication channels in lieu of cables and repeater stations.

Air Force Adds Ships To Missile Testing Range

The Air Force has added five ships to the "fleet" which is gathering telemetered data from missiles and satellites along part of the 5,000-mile missile test range, stretching from Cape Canaveral, Fla. to Ascension Island off the west coast of Africa.

The small cargo vessels with the maritime designation of CIMAVI are larger than the Air Force's six freight supply vessels which have been servicing the tracking range for more than a year.

The ships are operated by Pan American's Guided Missiles Range Division, and record impact data and chart the flight of missiles. The ships have headquarter bases at Recife and Trinidad.

They are a vital part of a vast system that watches the progress of U.S. "birds" from launch to impact.

(m/e news cont'd on p. 202)



USE BLOCKSOM Paratex CUSTOM-CUSHIONING FOR PRODUCTS THAT MUST NOT FAIL



Multi-Cavity Kit Pack



Fire-Control Component Pack

A Paratex pack is the only cushioning for delicate instruments of any shape, size or weight that permits a completely *Static Shape* and *Fully Neutralized* weight.

When the results of thousands of man-hours are tied up in the success or failure of a component or an entire missile, then BLOCKSOM Paratex cushioning is a necessity for moving or shipping your product.

CUSTOM ENGINEERED PACKAGING

Blocksom's staff of engineers has over 25 years of experience developing Paratex rubberized curled hair in custom designed cushioning that can't be equalled anywhere else.

PHONE or WRITE TODAY for complete information or for consultation at no cost to you.

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☐ Send me folder on Paratex Packaging
☐ Have packaging engineer call

*Name*_____
*Company*_____
*Address*_____
*City*_____ *Zone*____ *State*_____

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For accurate, reliable acceleration measurement...

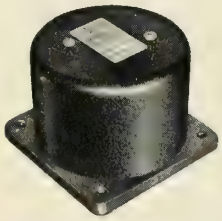
Pacific's

PRECISION LINEAR ACCELEROMETERS

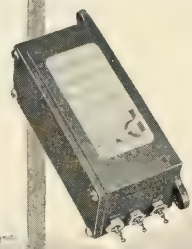
are rugged and right!



For High Response Systems . . . Series 4204
Linear accelerometer provides extreme sensitivity, large output AC signal. Maintains a high natural frequency and low cross talk. Temperature compensated **fluid damping** provides exceptional dynamic characteristics **without heater.**



Highly Accurate . . . Series 4202
Unique torsion-bar suspension gives very low hysteresis with exceptionally rugged, long life. Single or dual pot and/or switch pick-off provides versatility. Automatic caging mechanism.



Light and little . . . Series 4201
This miniature accelerometer is a versatile, high production instrument with unusual flexibility of design and performance characteristics. Maintains accurate signals thru long service life. Potentiometer pick-off.

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Each of the basic models illustrated at the right is representative of a series of similar units which vary only in output characteristics. They are available and were developed to satisfy a special requirement but can now be considered as standard production items...completely tooled, qualified, proved in actual use ...ready for immediate order.

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. . . m/e news

Antenna Company Forms California Research Unit

D. S. Kennedy & Co. of Cohasset, Mass., designers and manufacturers of large antennas for radio telescopes, communications, radar and tracking, has established a Palo Alto, Calif. research affiliate company.

Satellite-Kennedy, Inc. will conduct electronic, electrical and mechanical design research and development. Fred W. Morris, Jr., vice-president, will direct research and development, and will serve as engineering consultant and assistant to the president.

Marshall E. Mower is business manager, secretary and controller. Charles M. Brown is engineering and production manager.

New Unit Can Handle 10,000 Measurements

A two-unit digital data recorder-transcriber is now available that can make 10,000 measurements, in one second, of temperature, pressure, strain and other variables—4,800,000 separate pieces of information in eight minutes.

Developed by Davies Laboratories Division of Minneapolis-Honeywell, the system consists of a recorder, which absorbs data as electrical signals and converts into digits; and a transcriber, which has an electronic playback and selects and rearranges information for further computer processing.

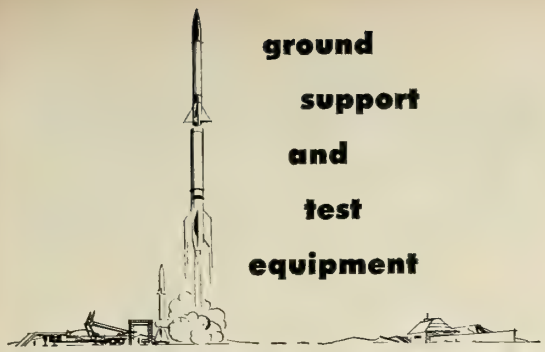
Western Electronic Show To Be Held in August

The Western Electronic Show and Convention to be held in Los Angeles August 19-22, is expected to attract more than 30,000 visitors. The exhibits will be held at the Pan Pacific Auditorium, and the technical programs and other events will run concurrently at the Ambassador Hotel.

For the first time, WESCON will be segregated into two separate exhibits. Three buildings will house the display of electronic equipment, test equipment and circuit components. The fourth pavilion will contain exhibits of electronic production equipment, raw materials and hardware. Hugh P. Moore, show director, said WESCON has grown to a size requiring that displays be categorized.

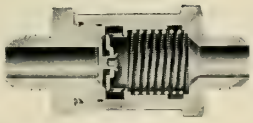
WESCON is the joint effort of the Los Angeles and San Francisco sections representing the 7th Region Institute of Radio Engineers and the West Coast Electronic Manufacturers Association.

(m/e news cont'd on p. 204)



ground support and test equipment

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No leakage. 3000 psi. Very low pressure drop. Can be furnished to open at ¼ to 35 psi. Brass, stainless steel, or aluminum alloy. ⅛″ to 2″ pipe or tube. Temp. range -65° to 200°F.

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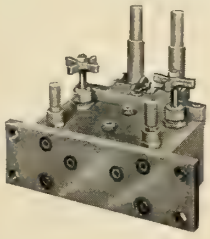
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For automatically maintaining height and level condition in any vehicle with air spring suspension. Controls swaying in transit, and off-level position while standing. Applicable to trucks, buses, trailers, carriers, cranes, etc.

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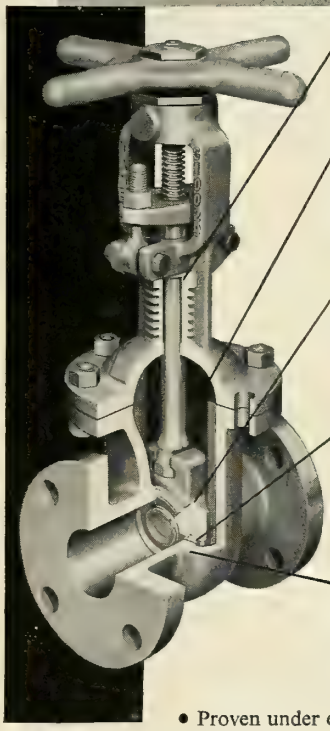
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Our job is to compute the performance of missiles in flight. Our output—authentic, concise, and accurate reports—contributes substantially to the advance of the missile sciences, and enables the Armed Services and Missile Contractors to evaluate field performance. The need for rapid and accurate analysis and evaluation of data is greater than ever before. So, it follows that our people are not only abreast of the state-of-the-art in data processing, but, in a very real way, it is we who establish the state-of-the-art, and keep it constantly moving forward.

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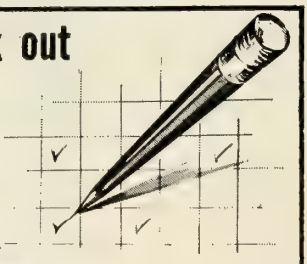
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. . . m/e news

Microsecond Camera Available for High Speed

An exposure time of 0.005 microsecond is now available with a high resolution camera manufactured by Electro-Optical Instruments, Inc., Pasadena, Calif.

The large aperture and high resolving power of the camera's electro-optical shutter unit permits photographic study of ultra high speed phenomena. Exposure can be synchronized to within 0.001 microsecond.

Designated Model KSC-50, it has a Crown Graphic "45" camera, electronically gated "Kerr cell" shutter unit, power supply, and a millimicrosecond electronic modulator.

The modulator has a high voltage "Kerr cell" pulse-forming network and an auxiliary synchronizing pulser, which gives a fast, high voltage pulse to trigger both the "Kerr cell" network and phenomenon under study. Adjustable delay can be introduced between the synchronizing pulser and "Kerr cell" network.

For versatility, alternate "Kerr cell" plug-in pulse forming networks allow a selection of exposure times from 0.005 to 0.1 microsecond. The modulator and "Kerr cell" module are separated by a flexible cable connection, allowing independent positioning of the camera and shutter unit.

Synchronous Motor Delivers High Torque

A hysteresis synchronous motor in BuOrd size 10 with a maximum length of $1\frac{3}{16}$", has been developed by the Mechatrol Division of Servomechanisms, Inc. It will operate directly from 115 volt line, 400 cycle, single or three phase, delivering .12 oz.-in. at 8,000 rpm pull-out torque.

The same unit can be supplied with a gearhead, with a maximum length of $2\frac{1}{8}$" up to a ratio of 200:1, and with a maximum length of $2\frac{3}{8}$" up to 10,500:1.

Space Weather Bureau To Track Meteoroids

Creation of an "outer space weather bureau" to track and avoid deadly clouds of meteoroids may be needed for man's successful conquest of space, A. Douglas Aircraft company scientist said.

A. M. Mayo, an equipment and safety research engineer, said the science of predicting and locating high concentrations of meteoroids or "space debris" may become "at least as im-

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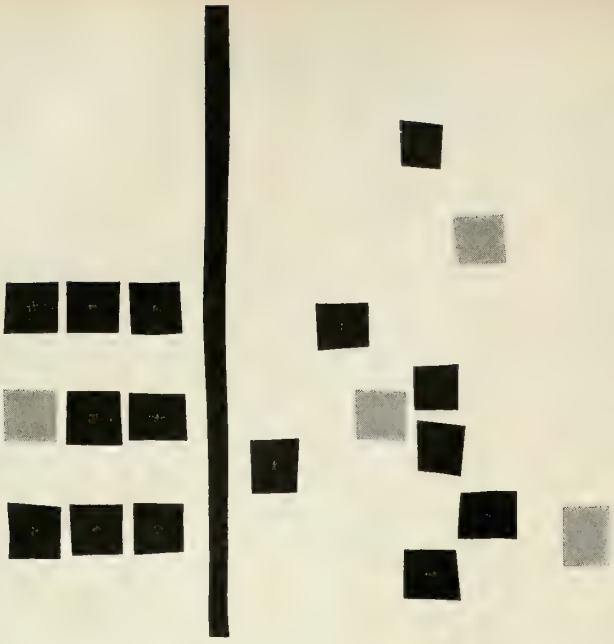
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11-19



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SYSTEM DEVELOPMENT CORPORATION

An independent nonprofit organization, formerly a division of the Rand Corporation

. . . m/e news

portant as that of meteorology or weather forecasting on earth."

Mayo disclosed that pitting, temperature rise, and penetrating effects of meteoroids present increasing problems as new count data becomes available. In addition, he said, heavier concentrations of debris are known to exist in the tails of comets and in the form of "space dust clouds."

Mayo also advanced a series of complex factors which could lead to a new theory on penetration of the structural skin of a space craft.

Explaining the phenomena created by minute meteoroids striking the skin at hypersonic impact speeds, the Douglas engineer said the energy from impact is dissipated in the form of radiation, ionization and evaporation of material, melting, heating and physical displacement.

In addition to designing the most effective primary penetration resistance into the outer shell of a space vehicle, Mayo indicated it may be desirable to incorporate another inner surface with automatic sealing qualities like those found in self-sealing tires and tanks.

He also revealed that data from satellite tests currently being conducted by the U.S. should soon be available in sufficient quantity to help science solve the meteoroid penetration problem.

Electronics

EIA Convention Hears Industry Report

In a recent annual report to Electronic Industries Association members, the president of the association, Dr. W. R. Baker, pointed out that despite some falterings in the U.S. military program and in the face of an economic decline, the electronics industry has continued to grow.

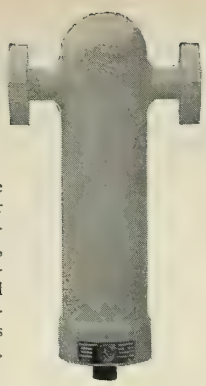
Dr. Baker's report was given at the annual EIA membership meeting at the organization's 34th convention in Chicago.

"According to estimates of our Marketing Data Department," Dr. Baker continued, "the dollar value of manufacturers' sale was $7.5 billion compared with $5.6 billion in 1956-57.

"Since the abortive cutback in military spending in 1957, Russia's *Sputniks* have reversed the trend, and today's military procurement program is at its highest peacetime rate. More significantly to us, the percentage of Defense Department funds being used to purchase electronic equipment and components has risen at an even more rapid rate.

(m/e news cont'd on p. 208)

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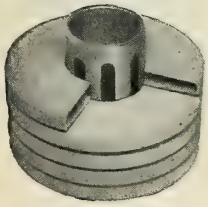


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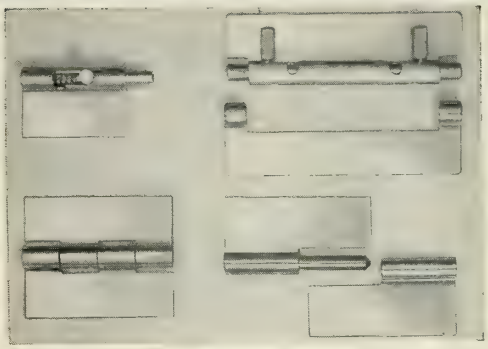
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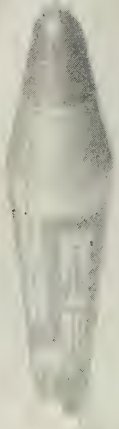
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. . . m/e news

"Before the Korean War electronics accounted for approximately 10% of military purchases. Currently the rate is 24%, and budget figures for the next fiscal year, now before Congress, indicate this figure may rise to 30% in 1958-59 and go higher thereafter," the EIA chief added.

"It now appears that the military electronic segment of our industry is now undergoing severe changes. Increasingly complex manufacturing requirements and military dependence on constant research and development have narrowed the field of qualified bidders. The need for small numbers of highly specialized components often has made it unprofitable for a manufacturer to produce them. The day when an electronic hardware manufacturer could turn out standard components or equipment in large volume for the military seems to have ended—at least for the present," Dr. Baker stated.

• **Roll with punch**—He reported that the industry is "never one to cry too long over spilt milk. Long accustomed to quick changes to meet competition, the electronics industry, I'm confident, will adapt itself to the changing times and market conditions, whether for the military or the commercial customer."

"In fact, the industry already has changed its production mix drastically since 1950. Between 1952 and 1957, the home entertainment business dropped from 58% to 20% of total electronic sales, while the military share rose from 20% to more than 52%. Industrial electronic sales, which were negligible a decade ago, now are running close to radio-TV-phono equipment in dollar volume."

Dr. Baker continued, "Perhaps the most significant EIA action during the past year was the decision of our Board of Directors to recommend that the Federal Government make a long-range study of the radio spectrum. The purpose of this proposal was to bring about a realistic readjustment of frequency allocations in the light of technological improvements and to avoid a chaotic condition in the future due to increasing channel requirements of both our military and industrial services."

"While the Government has not yet acted upon our request, it is being given serious consideration in high places and I hope eventually will be adopted. EIA stands ready to assist the Government in organizing industry cooperation in the study once it is authorized."

"Despite transitory setbacks such as we have experienced during the past

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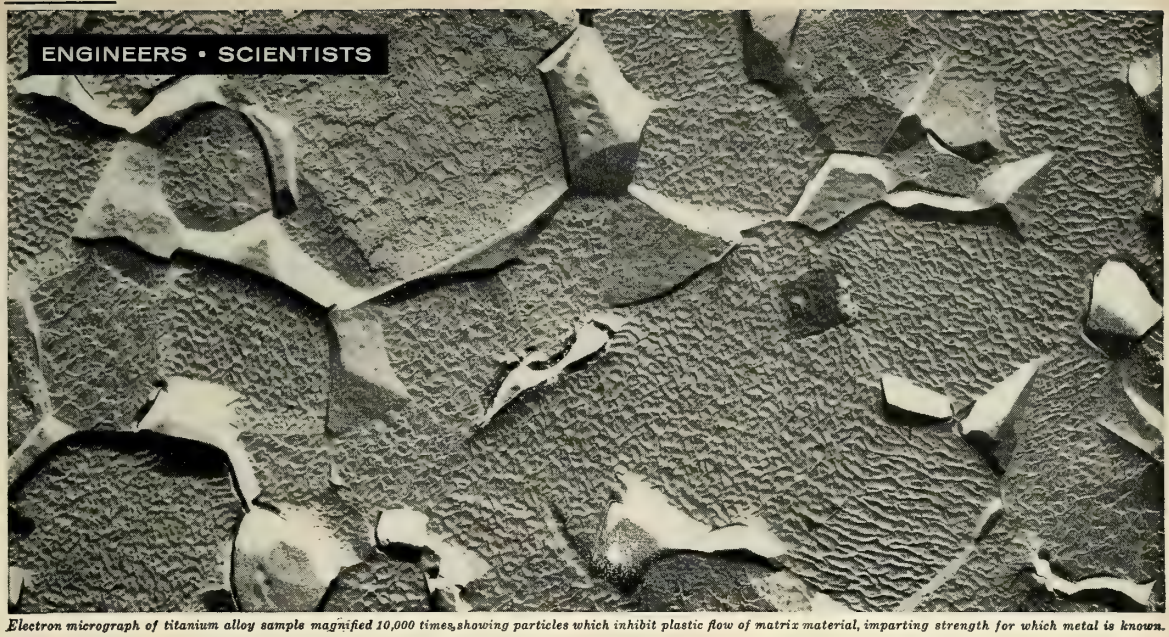
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year, the growth potential of the electronics industry is as sound as ever. It has expanded twelve-fold since World War II, and we are still just on the threshold of the electronic era."

"One reads a lot nowadays about the forthcoming space age which will replace the present missile age. It's too early to foresee accurately what effects this transition will have on our daily life and our economy. But, like the famed G-1 whose legendary "Kilroy was here" was reputedly found scrawled when troops landed in World War II, I'm sure that wherever man goes in his interplanetary flights electronic signals will have preceded him. Electronics also will guide his flight and keep him in touch with home base," the EIA chief concluded.

missile electronics briefs

The rush by many big companies to establish separate electronics divisions continues with the latest to report being Ryan Aeronautical Co. The new division is to be called Electronics Division, and will develop and produce doppler navigators and guidance systems at San Diego.

The recent lull in IRBM testing could be termed a gain for electronics reliability. In the past, big missile development almost always depended on guidance and control systems delivery and performance. Latest tests were delayed because of gear-box trouble. Reportedly, guidance systems had no part in the long layoff.

The furor about ion propulsion makes no mention of one basic fact—ion propulsion will only be practical, in the early days at least, as the propulsive means after the vehicle it is propelling has escaped the atmosphere. Practical systems will probably have to depend on engines using liquid for takeoff, solid for further acceleration, and plasma for escape velocity before any sort of an ion engine can take over. After that, the advantages of ion propulsion are spectacular—just figure the velocity of an object under constant acceleration for *THREE MONTHS!*

Lt. Gen. C. S. Irvine sounded the latest in a series of veiled warnings to contractors recently, when he criticized cost-plus-fixed-fee contracts as "the easy way out." He continued by saying that if contractors can't meet the general parameters of a contract, "we won't pay them a nickel." This, on top of indications that the Department of Defense is considering penalties for late delivery on CPFF contracts, might be the first step in a get-tough policy designed to save some of the battered dollars pumped into missile programs.

The recent partial unveiling of the new "Global Surveillance" system, (first reported in the May issue of m/r), by the Defense Department caused a minor furor in some companies where research towards the same goal had been proceeding on a company-financed basis for more than a year. Project ARGUS, reported elsewhere in this issue, is the code name designated by ARPA for studies in this area.

A new record level of electronic spending near $7.5 billion for FY 1957-58, up from $5.9 billion for the previous year, was reported by Frank M. Mansfield, chairman of Electronic Industries Association's marketing data policy committee. Military share of this amount is $3.9 billion, compared to last year's $2.8 billion. Replacement parts spending is up to $950 million and probably includes a good share of military spare parts procurement.

USAF contract to Electronic Specialty Co. for Project PANDA, described as being applicable to "several major missile programs" might mean that nuclear warheads are being considered for more than the presently-announced missiles. PANDA reportedly is an improved fuze for a nuclear warhead. Although PANDA was originally for *Genie* air-to-air missile, funding for the *Genie* has been stopped. PANDA will continue because of its technical advantages and lower cost, compared to existing fuzes of its type.

Chatham Electronics Division of Tung-Sol contract from the Signal Corps for evaluation and development of electron tube glasses resistant to radiation damage, is another indication of an almost all-nuclear missile arsenal. Only some of the older missiles use electron tubes. However, glass-enclosed transistors might be the reason for this contract.

AIEE, ARS, ISA, and IAS will cosponsor the National Telemetering Conference at the Lord Baltimore Hotel, Baltimore, between the 2nd and 4th of June. Program will include sessions on systems, data processing, components and equipment, and research associated with oceanography, astronomy, cosmic ray studies and rocketry. Banquet speaker June 3 will be Admiral Blinn Van Mater, USN (Ret.), whose subject will be "Telemetering in the I.G.Y."

Another prediction of growth in the electronics field was made recently by Don G. Mitchell, president of Sylvania Electric, when he estimated that the Armed Services would spend $4.33 billion on electronic defense this year. He attributes the record-breaking level to "amazing scientific breakthroughs" in such technical areas as missiles and anti-missile systems, electronic detection and warning systems, and a number of other electronic defense activities. He went on to say that "the entire concept of national defense has passed forever from the realm of being essentially an Armed Services responsibility, and rests equally on the shoulders of industry."

Barron's financial weekly reports Joseph W. Crosby, president of Thiokol Chemical Corp. as saying "The rocket industry is going to make a lot more money this year. As for others in this missile business—many of them our customers, of course—I don't think there's any question that most will also do well from here on out. After all, missiles have nowhere to go but up."

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Advertisers Index

	Page
Acme-Newport Steel Co., Sub. Acme-Steel Co.	11
Aerojet-General Corp., Sub. General Tire & Rubber Co.	17
Aerotest Laboratories, Inc.	132
Aircraft Armaments, Inc.	85
Airdrome Parts Co.	10
AiResearch Mfg. Co., Div. Garrett Corp.	170
Allegheny Ludlum Steel Corp.	142
American Airlines Inc.	128
American Bosch Arma Corp.	116
American Brass Co., The, Metal Hose Div.	121
American Cystoscope Makers, Inc.	207
American Tube Bending Co., Inc.	120
Armco Steel Corp.	87
Atlantic Research	30
Avion Div., ACF Industries, Inc.	32
Baldwin-Lima-Hamilton Corp., Electronics & Instrumentation Div.	146
Standard Steel Works Div.	197
Bausch & Lomb Optical Co.	28
Morris Bean & Co.	171
Belfab Corp., The	22
Bell Aircraft Corp.	178
Bendix Aviation Corp., Pacific Div.	95
Red Bank Div.	83
Billings and Spencer Co., The	169
Binkley Mfg. Co.	186
Blocksom & Co.	201
Bourns Laboratories	35
Brunswick-Balke-Collender Co., The	38
Brush Instruments, Div. of Clevite Corp.	84
Burklyn Co.	207
Burroughs Corp.	29
CDC Control Services, Inc.	16
Cannon Electric Co.	20
Cannon-Muskegon Corp.	161
Canoga Corp.	47
Chance Vought Aircraft, Inc.	112, 113
Chicago Bridge Iron Works	123
Coleman Engineering Co., Inc.	25
Computer Control Co., Inc.	24
Consolidated Diesel Electric Corp.	12, 13
Consolidated Electrodynamics Corp.	50, 196
Continental Aviation & Engineering Corp.	156
Cutler-Hammer, Inc.	141
Data-Control Systems, Inc.	111
Daystrom Inc., Daystrom Instrument Div.	60, 133
Delavan Mfg. Co.	188
Delco Radio Div., General Motors Corp.	88
Diversey Engineering Co.	8
Dow Chemical Co., The	180
Edgewater Steel Co.	27
Thomas A. Edison Industries, Inc., Instrument Div.	164
Elastic Stop Nut Corp. of America	137
Electrical Engineering & Mfg. Corp.	115
Electro Instruments, Inc.	124
Electro Tec Corp.	172
Electronics & Instrumentation Div., Baldwin-Lima-Hamilton Corp.	146
Elgeet Optical	91
Ellis and Watts Products, Inc.	150
Engelhard Industries, Inc.	157
Engis Equipment Co.	36
Fairchild Camera & Instrument Corp.	14
Fansteel Metallurgical Corp.	152, 153
Filtron Co., Inc.	31
Flexonics Corp.	179
Fluid Regulators Corp.	102
Food Machinery & Chemical Corp.	46
General Chemical Div., Allied Chemical Corp.	149
General Electric Co.	117, 138
Genisco, Inc.	63
G. M. Giannini & Co., Inc.	198
Glassco Instrument	157
Goodyear Aircraft Corp.	3
Hammer Valves, Inc.	203
Harman Equipment Co.	207
Hart Mfg. Co., The	139
Ira Haupt & Co.	210
Haws Drinking Faucet Co.	122
Hewitt-Robins Industrial Products	151
Hofman Laboratories, Inc.	200
Johns Hopkins University	57
Hughes Aircraft Co.	160
Hunter Douglas Aluminum, Div. Bridgeport Brass Co.	192
Hunter Mfg. Co.	5
Hydro-Aire, Inc.	2
Indiana Gear Works, Inc.	99, 100
James, Pond & Clark, Inc.	105
Janitrol Aircraft Div., Surface Combustion Corp.	158
Jet Propulsion Laboratory, Calif. Inst. Technology	86
Jordan Electronics	65
Kaman Aircraft Corp.	181
Kearfott Co., Inc.	129, 131
Kett Technical Center, Inc., Sub. U. S. Industries, Inc.	177
Kollmorgen Optical Corp.	51
LaVezzi Machine Works	200
Lebanon Steel Foundry	82
Linear, Inc.	118
Link Aviation, Inc.	145, 190, 191
Lockheed Aircraft Corp., Missile Systems Div.	108
Lone Star Plastics Co., Inc.	85
Lukens Steel Co.	92, 93
Mallory-Sharon Titanium Corp.	199
Johns Manville Corp.	33
Marion Electrical Instrument Co.	24
Marman Div. Aeroquip Corp.	103
McCormick Selph Associates	62
McDonnell Aircraft Corp.	162, 163
National Advisory Committee for Aeronautics	53
National Airlines, Inc.	193
Newbrook Machine Corp.	98
Norris-Thermador Corp., Norris Div.	59
Northam Electronics, Inc., Sub. Norris-Thermador Corp.	148
North American Aviation, Inc.	182
Northeast Circuit Sales Co.	122
Nuclear Products, Erco Div., ACF Industries, Inc.	184
Pacific Scientific Co.	202
Packard Bell Electronics, Technical Products Div.	4
Perkin Elmer Corp., The	154
Phoenix Products Co.	189
Pittsburgh-Des Moines Steel Co.	26
Pressed Steel Tank Co.	56
Radio Corporation of America	61
Ramo-Wooldridge Corp., The	81
Raytheon Mfg. Co.	54
Reaction Motors, Inc.	214
Reeves Soundcraft Corp.	58
Republic Mfg. Co.	203
Republic Steel Corp.	155, 157, 159
Resistoflex Corp.	6
Rheem Mfg. Co., Aircraft Div.	213
Robinson Aviation, Inc.	104
Rochester Mfg. Co., Inc.	48
Ryan Aeronautical Co.	130
Saginaw Steering Gear Div., General Motors Corp.	127
Sanborn Co.	18, 19
Servo Corporation of America	34
Shell Oil Co.	15
Simmons Fastener Corp.	187
Skydyne, Inc.	204
Stalker Development Co.	132
Standard Steel Works Div., Baldwin-Lima-Hamilton Corp.	197
Sterling Precision Corp.	106
F. W. Stewart Corp.	24
Sundstrand Aviation, Div. Sundstrand Machine Tool Co.	195
System Development Corp.	206
Telecomputing Corp.	167, 204
Temco Aircraft Corp.	90
Thiokol Chemical Corp.	168
Titanium Metals Corporation of America	23
Trans-Sonics, Inc.	136
United Aircraft Products, Inc.	94
United States Gasket Co.	194
Vapor Heating Corp.	110
Vickers, Inc., Marine & Ordnance Dept.	43
Western Gear Corp.	119
Westinghouse Electric Corp.	55
Westvaco Chlor-Alkali Div., Food Machinery & Chemical Corp.	66
Worklon, Inc.	207

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EMPLOYMENT SECTION

	Page
General Electric Co.	208
Martin Co., The, Denver Div.	208
Republic Aviation Corp.	209

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POWER SUPPLY. A 72 channel strain gauge power supply for use in a rocket engine test stand features resistance to ground of more than 10,000 megohms, and internal noise level of the unit with respect to ground of less than 5 microvolts peak to peak. Known as Model 7P01-A, each of the 72 channels has 115 volts 60 cycles ac input. The nominal output of 10 volts is adjustable. In normal operation, used with a regulated power source, the output voltage varies less than 1/10 per cent. Designed to operate in a temperature range of 0-45° Centigrade. Output voltage is constant under this temperature variation plus or minus .025 per cent. Output voltage has less than 1 millivolt ripple peak to peak. Built for rack storage, each tray contains 6 power supply channels. Western Gear Corp.
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• • Advertisements

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125
126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150
151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175

• • Missile Literature

200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224

• • New Missile Products

225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245	246	247	248	249
250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	274
275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299

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MISSILE LITERATURE

CERAMIC RADOMES. Three reports of Air Force-sponsored research into the possible use of ceramic materials in radomes to withstand high operational temperatures of future aircraft and missiles have just been released for industry use. The volumes are available from the Office of Technical Services, U.S. Department of Commerce.
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FLIGHT ACCESSORY POWER. Publication GED-3325, 20 pages, an illustrated booklet which briefly discusses functions, features and applications of various flight accessory power equipment. Types of equipment included are electric power, hydraulic power, missile accessory power, starting power, turbopumping and turbo-actuation. Booklet is intended to give assistance in the selection of this equipment. General Electric Co.
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TEST JIGS. Two page bulletin describes the use of Models 4021 and 4022 manual core test jigs, in quickly setting-up metallic tape-wound and miniature ferrite magnetic memory cores, for testing and analysis. Each model is illustrated, showing design and construction features. A circuit diagram and complete specifications are included. Rese Engineering, Inc.
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SILICON HANDBOOK BIBLE. Sixty-four page book explains the technicalities of silicon rectifiers, how they are made, where they are used, and how to use them in many applications. Audio Devices, Inc.
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SUBMINIATURE RELAYS. Catalog describes sensitive and high-speed miniature relays, as well as micro-miniature relays in both voltage-sensitive and current-sensitive models. Besides specifications, the catalog contains adjustment schedules, dimensional and circuit diagrams. A special section includes data and charts for computing the characteristics of relays under varying conditions of resistance, current, voltage, power and temperature. This section also graphically covers allowable limits of contact chatter and dynamic contact resistance under vibration and shock, together with methods for protection of contacts under inductive load. Iron Fireman Manufacturing Co.
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PRECISION RESISTORS & NETWORKS. Four-page, two-color brochure lists facilities for design, engineering, production and quality control of precision resistors and resistor networks. Mepco, Inc.
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ELECTRONICS R & D. Four reports of Armed Forces research include data on development of a Stable High Sensitivity Multiplier Phototube; Study of the Effects Produced by Asymmetries in the Two-Helix Backward-Wave Amplifier; Electrostatically Focused Laminar Flow Electron Beams; and Secondary Emission Ratio of Storage Tube Insulator Films. Dept. of Commerce.
Circle No. 206 on Subscriber Service Card.

FLOW RATE CALIBRATION. Service described in six-page folder listing facilities, calibration ranges and temperatures, special studies, accuracy, an other data. Cox Instruments.
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PLASTIC LAMINATES. Copper-cla plastic laminates for electronic printe circuits are covered in a technical bul letin now available. The laminates ar described as a combination of high purity rolled copper on plastic bas materials. Four-page brochure include data on physical, mechanical and elec trical characteristics of the four grade now in production. Taylor Fibre Co.
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BRAZED COMPONENTS. Booklet de scribes company facilities, personne and production capabilities in desig and fabrication of experimental, proto type and production quantities of com ponents. Use of new super alloys an stainless steels, together with latest tech niques of silver alloy and nickel allo brazing in controlled atmosphere fur naces, is also covered. Ferrotherm Co
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ELECTRO-MECHANICAL CATALOG Features drawings and performanc curves of over 120 electric motor linear actuators, rotary actuators, sole noids, power units, screwjacks, gear boxe and electronic test equipment. Als contains considerable design data o guided missiles, ordnance and aircraft and industrial fields. Hoover Electric Co
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CERAMIC CAPACITORS. Bulletin de scribes line of subminiature ceramic capacitors, including power factors, tol erances, temperature ranges and char acteristics. Mucon Corp.
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ZENER SWITCHING CIRCUITS. High Speed zener switching circuits and thei application to computers. Intended to illustrate that computers, limited in op eration and performance when handling information rates in excess of 2.5 mc can circumvent the upper limit by use of silicon junction diodes. Permits a re versal time with speed theoretically as short as one one-billionth of a second. Hoffman Electronics Corp.
Circle No. 212 on Subscriber Service Card.

CONNECTORS. Illustrated bulletin gives specifications, outline dimensions and general information on connectors de veloped for aircraft/missile applications. Connector is available in 51 and 55 contacts, either hermetically sealed or with conventional contact mounting. Mineral-filled melamine plug insert is enclosed in aluminum anodized coupling shell. An O-ring seals mating surfaces of receptacle and socket. DeJur-Amsco Corp.
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LIQUID HEATER. Unit with output variable from 0 to 1 million btu/hr. has been designed for missile ground support applications. The unit automatically maintains liquid at any desired temperature and operates as a complete heating system for such applications as missile fuel heating during transfer, vaporizing, maintaining liquid temperature during storage, providing personnel comfort heat in buildings and support vehicles. Janitrol Aircraft Division, Surface Combustion Corp.
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26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125
126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150
151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175

• • Missile Literature

200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224

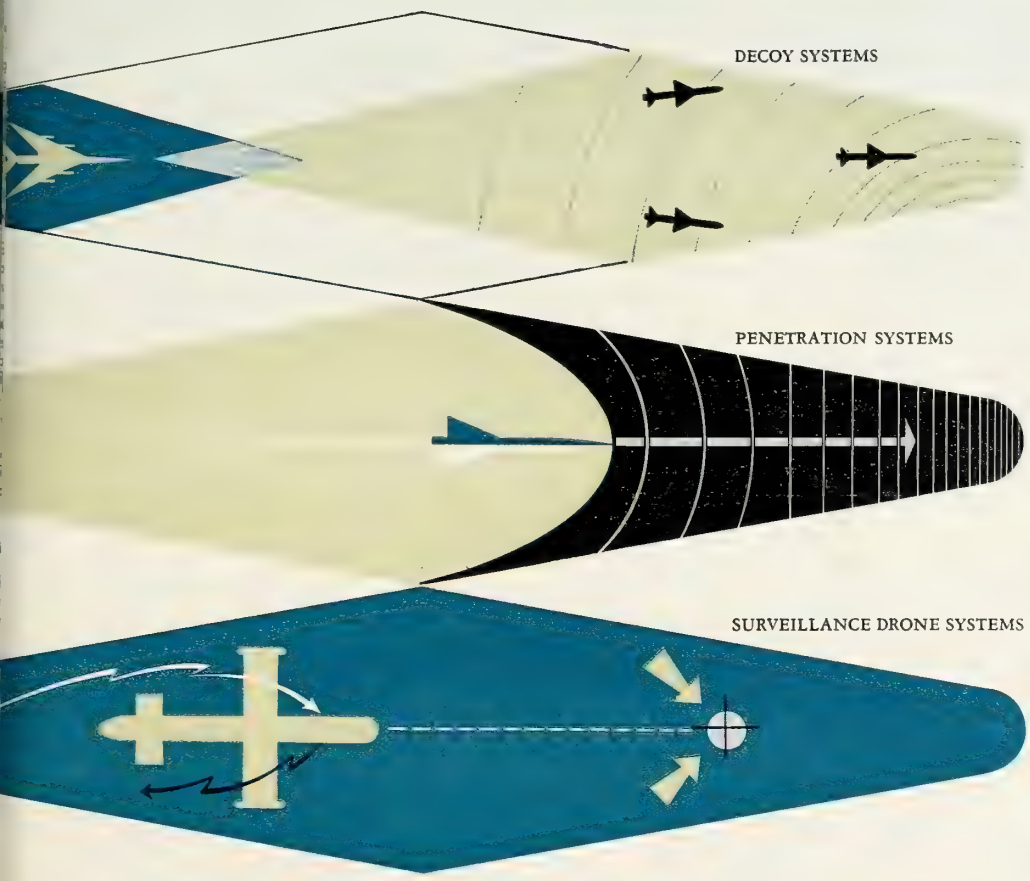
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250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	274
275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299

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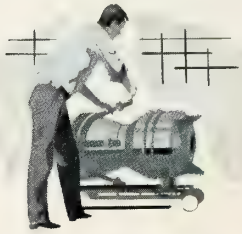
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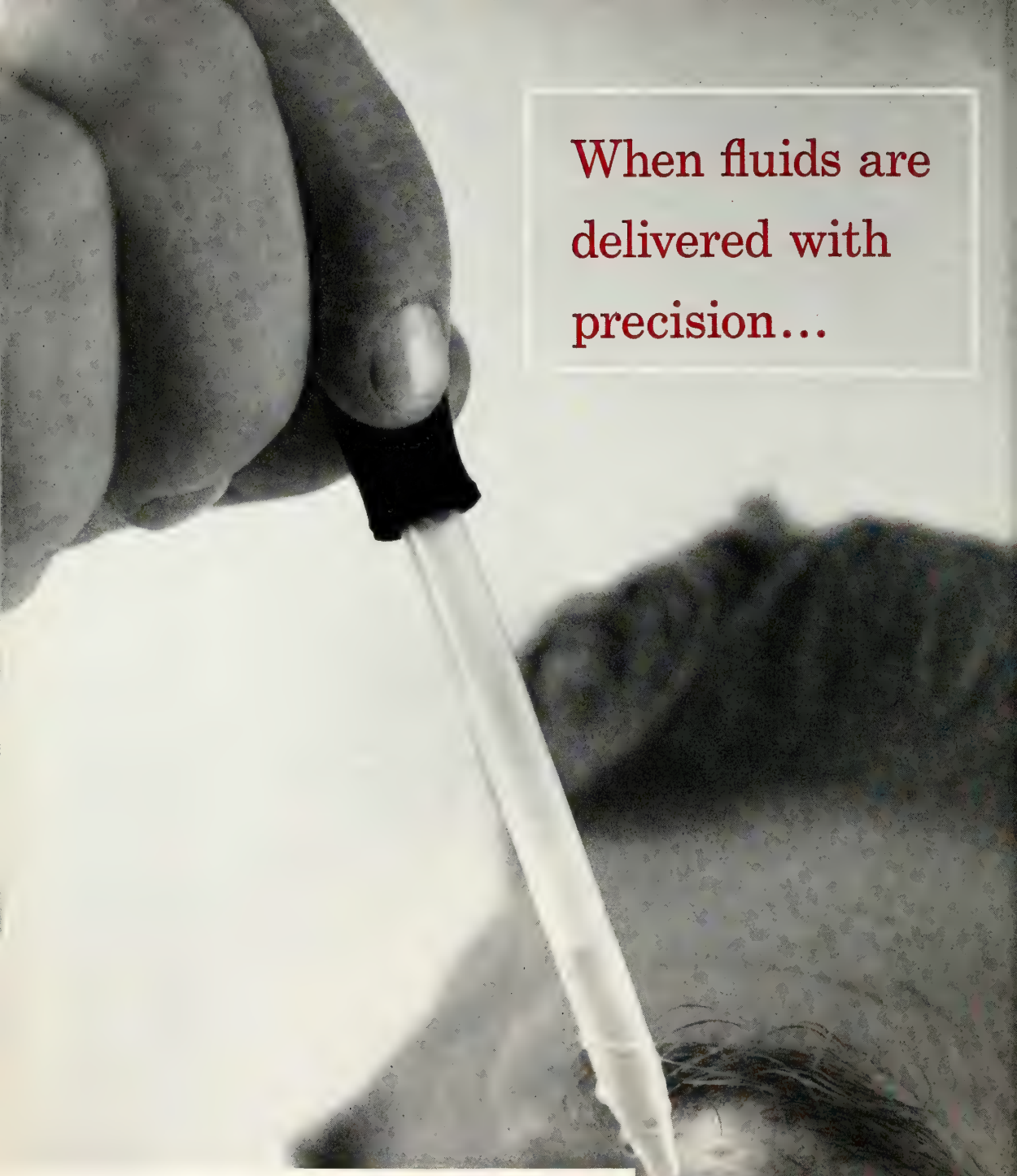


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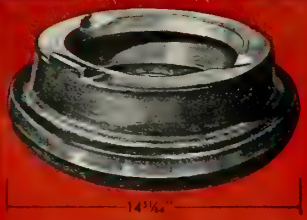


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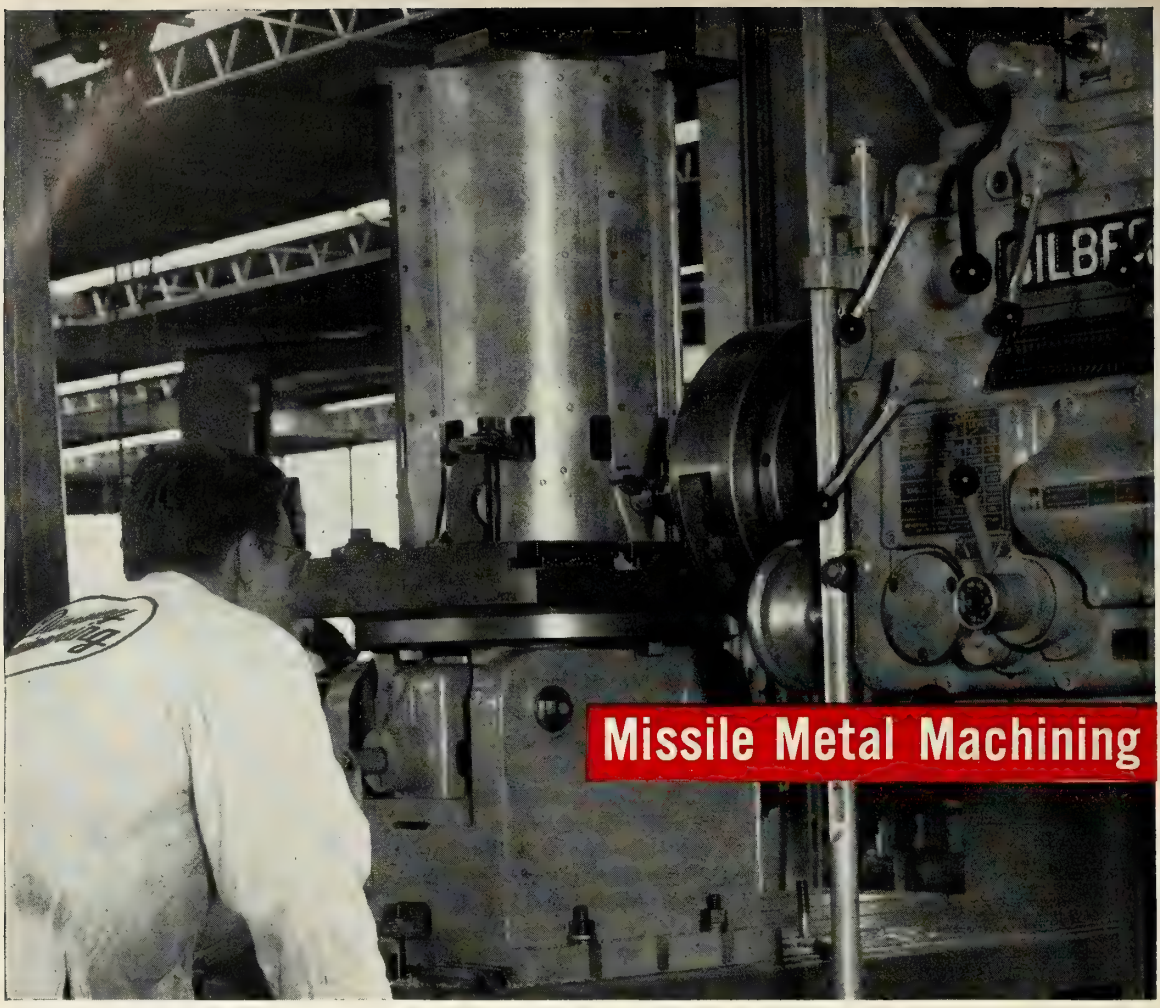
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editorial viewpoint . . .

Announcement by United Aircraft Corporation that it is creating two new missile divisions is good news.

United is the last of the great aviation industrial giants to take the plunge into the vast and growing field of astronautics.

In a dozen short years, every large aircraft firm in the country has thrown its resources and skills into the missile and space industries.

Immediately after World War II, two leading aircraft builders, North American and Convair, clearly saw the trend—rockets and missiles would inevitably supersede manned military aircraft for many purposes when these vehicles had passed through a few more speed and power cycles.

For five years after World War II, J. H. "Dutch" Kindelberger, for North American, and Tom Lanphier, Jr., for Convair, fought desperately for funds and programs to launch the missile era. But in those days, USAF had far more missions to perform than it had funds to work with. Only through the perseverance of the aircraft firms were the early missile projects kept alive.

As the early stages of astronautics attained recognition, when Korea forced the nation to re-appraise its defenses on a permanent basis, the aircraft industry, firm by firm, entered the missile field.

And now United Aircraft receives its "welcome aboard". Today, more than ever before, the missile industry needs the resources of facilities, mindpower and manpower—and in particular, the precision manufacturing skills—which United can contribute to expand the astronautics frontier and insure our survival as a free nation.

United will bring to the missile and space field the invaluable resources of more than 60,000 employees, some 12 million square feet of industrial space, and working capital in the hundreds of millions, all garnered through a quarter of a century of experience and contribution to aviation. It will continue heavily in aviation, of course, for the jet age is heavily dependent upon it, but we predict with confidence that United is destined to become a major factor also in the science of astronautics.

The cycle that began with North American and Convair is now virtually closed with the addition of United Aircraft. This is all to the good.

contents

news

Soviets, U.S. Race for Moon .. 9
Killian Outlines Science Policy . 11
Missile Industry Meet 11
Thor Engine Reaches Production Tests 23
Army Plans Million Pound Thrust Stand 26
Labor Moves into Missile Field 33
Moss Attacks Snyder Censorship 34
Project Ammo Shows Missile Strength 36

departments

Industry Report 13
Industry Countdown 38

columns

The Missile Week 7
Propulsion Engineering 18

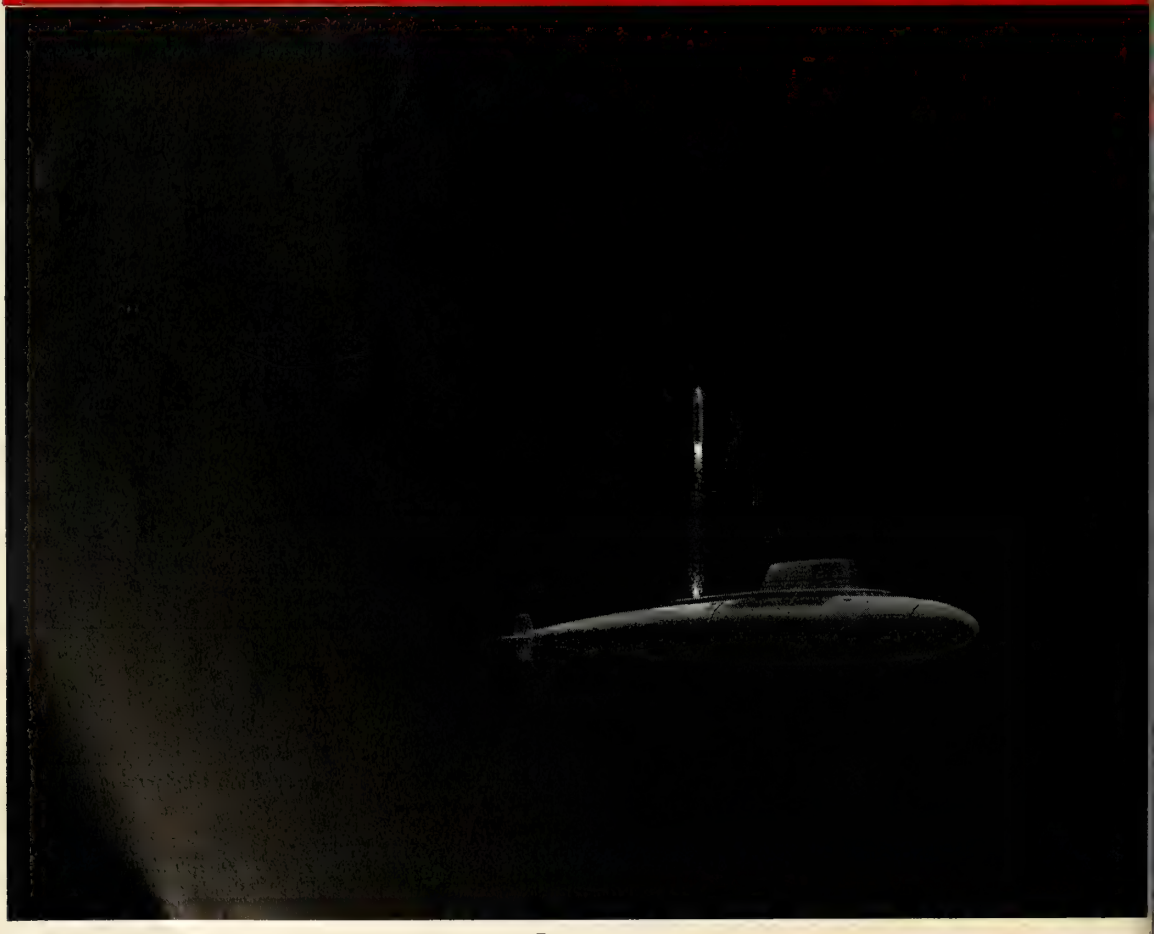
The cover

The 150,000-lb thrust engine for the Thor IRBM is subjected to a hot firing at Test stand 1 on Rocketdyne Neosho's test facilities. Enginees are currently being produced at Rocketdyne's nearby fabrication plant. Each engine is run for 15 to 30 seconds in a 'sample' qualification test before delivery to BMD (see engine test story pages 23-24).

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the missile week

An m/r staff report from WASHINGTON

• **The complete Fleet Ballistic Missile** submarine system should be in operation within 18 months, said Rear Admiral Rawson Bennett, Navy's chief of Research to the Senate Appropriations Committee hearings. Development and Production of both the submarines and the *Polaris* missiles are "in step". Bennett told the dollar-conscious lawmakers normal production cost of the *Polaris* will be about one half present costs.

• **Science fiction** reared its head (mechanical brain and all) and became reality this week when the Navy unveiled the first non-biological system capable of perceiving, recognizing and identifying its surroundings. The "Perceptron", as the system is called, closely parallels the "similarity" or recognition functions of the human mind. A conventional IBM 7C computer has been used to simulate the Perceptron system. The system, developed at the Cornell Aeronautical Laboratory, Inc., Buffalo, under contract for the Office of Naval Research, is seen to have numerous applications in aeronautical and space operations. Navy scientists say it is within the reach of the Perceptron to read print and script, and even respond to verbal commands.

• **According to ARPA,** Project Wizard is out of the picture as an anti-missile-missile system. The last $3 million budget allocation was for BMEWA (Ballistic Missile Early Warning System), mainly for long range radar missile detection system. This gives added impetus to the *Nike-Zeus* development team, which is coordinating its investigations with the ICBM and IRBM flight tests program at Cape Canaveral.

• **Senate and House conferees** can be expected within days to work out a mutual settlement on legislation which will create the new National Aeronautics and Space Administration/Agency. Neither committee has an axe to grind. The House position is that members want a strong leadership, with the director having almost complete authority and control. The Senate, on the other hand, is more inclined toward policy and advisory boards which would limit the NASA director. It can be expected that a "middle ground" will be reached, and legislation should be on the President's desk before mid-July.

• **There's not too much** name tossing for the new director of NASA except that of Dr. Hugh Dryden, present NACA director, and by all evidence, the leading contender. As one legislator put it: "we would like to have a man with Admiral Rickover's drive, Dr. James Killian's scientific background, and Admiral John Hayward's clearness of vision. At this time, it looks like Dr. Dryden has some of the characteristics of all three."

• **Speaking of names,** you can put your money on one of three well-qualified men who have been suggested to become head of NASA's new Space Technology Division, under Dr. Dryden. They are: Dr. William H. Pickering of JPL; Dr. James A. Van Allen of the University of Iowa, and Dr. H. Guyford Stever of MIT, present chairman of NACA's Special Committee on Space Technology.

• **The President's reorganization** plans for the military received a major setback—at least in Congress—when DOD Secretary McElroy told newsmen at Quantico he was "disappointed" in Admiral Burke's testimony in opposition to some of the recommendations. He didn't mean it the way it was interpreted. Being relatively new to the Washington scene, the Secretary was saying exactly what he did mean. He was simply disappointed. In any case, he should have the sympathy of his predecessor who frequently suffered galloping attacks of the same ailment.

• **Postscript:** though new to the Washington scene, Mr. McElroy is learning fast about other facets of Capitol thinking. In reference to a question on what he expected the Senate to come up with in the way of a reorganization bill, he said he expects a better bill than the House provided. How so? "Well, I just think sometimes what you hear isn't necessarily entirely what they (the Senators) think." Sound reasoning, Mr. McElroy.



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JULY 7, 1958
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ARPA Pushes Moon Try; Reds May Win

Red Moon Program in High Gear, Report Says; Army Gets Approval for Third Lunar Probe?

by Erik Bergaust

The U.S. Army and Air Force have been told to launch their lunar probes "as soon as possible." The Army has just been given the go-ahead for a third probe—according to a top Pentagon official—although Army officials, including Secretary Wilbur Brucker, claim they know nothing about it. Originally, the Air Force was to launch three, and the Army one or two moon rockets.

Unlike the satellite launching attempts, either service may go first when it is ready. The Army can be expected to launch its first probe around July 30, with the Air Force probably making the attempt about August 25. The trip will take 4½ days, and payloads will vary from 25 pounds, with an ultimate payload of 100 pounds expected.

However, the first Soviet lunar vehicle is being readied at a launching site near the Caspian Sea, probably the same site that the Russians use for launching their *Sputniks*. Reports from several of m/r's reliable European sources indicate Russia's moon program is in high gear, and that the West soon will be "stunned by a most remarkable, outstanding space flight achievement."

• **Mechanics**—Army will use *Juno* II's *(Jupiters)* with a cluster of three *Sergeants* for the second stage, and a single *Sergeant* for the final stage.

AF will use *Thor*, with second stage *Vanguard* and a solid-propellant third stage, probably being supplied by Allegheny Ballistics Laboratory.

All probes will employ radar and radio tracking equipment, and will not be tracked optically. There will be experiments in escape velocity, and research in retro rockets for soft-landing in a later program.

Officials claim the U.S. is not trying to hit the moon for any world psychological reasons. The Defense Department will not make any advance release of firing dates to forestall bad publicity at home and abroad in case of failure.

One of the planned Army probes will contain approximately 60 pounds of heavy cosmic ray detection equipment. One or more AF probes will contain what amounts to a mechanical TV system for scanning the moon's surface. This scanner is being developed by the Naval Ordnance Test Station at Inyokern, California. (Some $200,000 has been authorized for the scanner). It is hoped that the device will give a first look at the other side of the moon.

One Army probe, and it probably will not be the first one, will contain one of the Land-type cameras which actually take a photograph that will be transmitted back to earth by electrical means. Another probe will determine its own location in space, and this could turn out to be a crude experiment for subsequent navigation in space.

Lunar probe payloads will also contain magnetometers for measuring the extent of the earth's magnetic field. They will also determine if the moon has a magnetic field, and what its measurements are. Nobody knows whether the moon has a magnetic field.



THE MOON—who gets there first? Air Force, Army—or Russians?

According to Dr. Herbert York, chief scientist, ARPA, "finding out whether or not the moon has a magnetic field and how large it is should help in determining why the earth has a magnetic field."

• **Funds for U.S. work**—Lunar probes are part of $72 million requested by ARPA in its fiscal year 1959 budget under the heading of "Other advanced research." It is estimated that the six probes will cost in the neighborhood of $60 million.

The Army and Caltech's Jet Propulsion Laboratory will receive $25 million of this for their lunar probe work. Fiscal 1958 funds authorized $11 million for *Jupiter* C probes and two or possibly three earth satellite launchings. Air Force was authorized $10 million for the *Thor-Vanguard (Thor-Able)* probes.

Of interest is that ARPA's method of circumventing the Pentagon's chain-of-command resulted in ABMA's Maj. Gen. John B. Medaris and AFBM's Maj. Gen. Bernard A. Schriever getting the go-ahead on the lunar projects in the phenomenal time of 12 days.

• **Target chances**—According to Dr. York, the chances of hitting the moon are about 25%, "even if we tried to." Chance of orbiting the moon is about another 50%, and the chance of missing entirely is about 25%. All percentages were given with the stipulation that there would be no rocket malfunctions.

If the probe is aimed to intercept the moon, and emerges from the earth's atmosphere at about 25,000 mph and then burns out, it will slow down gradually until about nine-tenths of the way to the moon.

Then, barely creeping forward, it will drift across the boundary line into the region where the gravity of the moon dominates. Accelerating slowly to 7,200 MPH, it will crash into the moon. If the rocket misses the moon by more than 2,000 miles, it may be accelerated past escape velocity by the moon's gravity, and not held in orbit. In that event, it would be carried off into space, or boomerang back toward the earth.

Lunar probes now under ARPA will be transferred to the proposed Na-



FIRST MOON PROBE? Army *Jupiter* with *Sergeant* second and third stages.

tional Aeronautics & Space Agency at a later date.

The optimum time for launching a rocket to the moon depends upon the type of experiment that is being conducted.

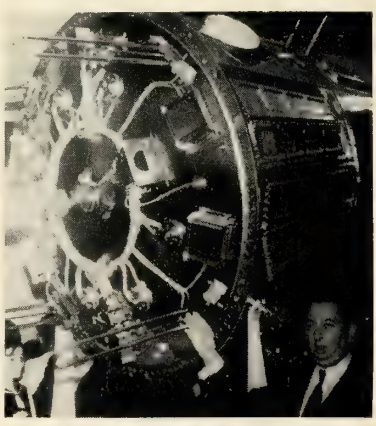
If a shot is attempted during the months of July and August, the most advantageous time would be during the new moon—July 30 and August 29. More specifically, if the shot is designed to scan either the near or far side of the moon, the shot should be timed so that the firing would take place just before the new moon and arrive in the vicinity of the moon shortly after.

In this way, the moon would not be completely dark on the out-going journey and a continuous fix could be made of the missile's position. When going around the moon, pictures could be taken of the far side in a condition of near 100% sunlight.

If the shot were made at the exact time of the new moon, there might be interference with radio emissions from the sun (sun-earth-moon will be in line during this time).

• **Russian plans**—One American space flight expert, Andrew G. Haley, who returned from the Soviet last week after having spent several days with the Soviet Astronautics Commission's members in Moscow and Leningrad, told m/r in an exclusive interview that the Red moon probe program appears to be progressing rapidly.

Last year, the Russians surprised the world by launching their first *Sputnik* during the International Astronautical Federation's congress in Barcelona. Some experts feel the communist government might copy this psychological approach this year and launch its first moon rocket just before this year's IAF meeting is held in Amsterdam, Holland, on August 25-30.



IAF PRESIDENT Andrew G. Haley with full scale model of *Sputnik* III in Moscow.

In m/r's report from the IAF congress, (Nov. 1957, p. 37) an interview with Russian Academician Leonid I. Sedov revealed that the Reds have the same approach as had been suggested in the U.S. for conquest of the moon. First, they intend to launch small impact probes or vehicles that will circumnavigate the satellite. Some vehicles will be equipped to take pictures of the moon's unseen side. Later, the Reds will attempt soft landings.

A successful lunar shoot is considered by many to be a greater feat—from a psychological viewpoint—than the launching of satellites. "For this reason, "an ARPA official told m/r, "it must be assumed that the Russians will try to beat us. And they have the qualifications to do it."

Reds Illustrate Manned Version of *Sputnik* III

An artist's sketch in an east European newspaper is being closely examined in the west as a possible clue to Soviet plans for future manned satellites.

The sketch, appearing in the Bucharest newspaper ROMANIA LIBERA, shows a rocket nose cone based on the dimensions of *Sputnik* III and carrying a man. The dispatch accompanying the sketch was from the Soviet news agency TASS, but the source of the sketch itself is not specifically identified.

The occupant of the satellite illustrated is shown encased in what appears to be a pressure suit equipped with a bubble helmet and seated in a semi-reclining position on an acceleration couch. There was no elaboration on the details of the illustration.

ARPA Authorizes Space-Radio Antenna

Advanced Research Projects Agency has authorized U.S. Army Ordnance Missile Command to construct a radio antenna capable of maintaining communications with space vehicles. This ground equipment will be used in later lunar probes by the Air Force and Army.

The 85-foot antenna—similar to radio telescopes used to find and track radio stars—will be built by Cal Tech's Jet Propulsion Laboratory, and is expected to be in operation by the end of this year. The multi-million dollar antenna will be located at the Goldstone Test Station in the southwest corner of Camp Irwin, Calif.

The site was chosen because it offers extremely low background noise levels. Principal contractors will be the Blaw-Know Co.; Collins Radio Co., and the Rucker Co.

Killian Outlines Science Policy

A national science policy, which he said would help keep the U.S. strong militarily and economically, has been outlined by Dr. James R. Killian, Jr., chairman of the President's Advisory Committee on Science.

Commenting that his program would also contribute to U.S. intellectual and spiritual vigor, Dr. Killian was principal speaker last week at the opening of Texas Instruments, Inc. new $5 million semi-conductor plant at Dallas.

The program, said Killian, should consist of:

1—"Adaption, as recommended by the President, of the organization and management of our military research and development to keep pace with changes in military technology.

2—"Achievement of a greater emphasis on the qualitative aspects of our national research efforts.

3—"Proclaim the importance of maintaining and increasing research and development in a time of recession, such as we now experience."

In connection with opening the new plant, Texas Instruments held an Industrial and Technology Day. The program was designed as a salute and tribute to the semi-conductor industry, in connection with the 10-year anniversary of the invention of the transistor.

Speakers included Brig. Gen. Earl Cook, chief of research and development, United States Army Signal Corps; Mark Shepherd, junior vice president, Semi-Conductor Components Division, Texas Instruments Inc.; Donald G. Fink, president, Institute of Radio Engineers; Wallace W. McDowell, vice president, IBM; J. A. Morton, director of Device Development, Bell Telephone Laboratories, Inc.; and Dr. Gordon K. Teal, assistant vice president, Central Research Laboratory, Texas Instruments, Inc.

The keynote address was given by M. J. Kelly, president of Bell Laboratories, Inc., where the first transistor was developed in 1948. In his speech, Mr. Kelly pointed out that transistors and diodes are now produced for a wide range of electronic applications.

"It is estimated that in 1957, there were some 30-million transistors and 60-million closely related semi-conductor diodes manufactured in the U.S.," said Kelly. "The dollar sales volume of these 90-million semi-conductor units was well in excess of $100-million. Some 600 transistor and 1,300 diode types had been standardized and received industry codes in 1957.

"It is predicted that the combined sales of transistors and diodes will reach a dollar volume in excess of $500-million by 1965. It is also expected that in 1965, the dollar volume of transistor and semi-conductor diode sales will be greater than that of the older electronic tubes.

"By 1975, transistor and diodes will serve perhaps 90% of the active electronic device applications, while the electron tube will still serve 10%.

Missile Industry Meeting Draws 600 to Sessions

Though the argument may still rage in some quarters as to whether there is a missile industry, there is no doubt of the fact that there is a missile market.

If there was any one conclusion to be drawn from the First National Missile Industry Conference, this is it.

Sponsored jointly by the National Rocket Club of Washington and the National Capital Section of the American Rocket Society, the first NMIC was held at the Mayflower Hotel, Washington, D.C., in June.

The first national meeting of its kind, it emphasized the business aspects of missiles and astronautics.

• **Awards made**—Highlight of the three-day meeting was the Dr. Robert H. Goddard Memorial Dinner, where two awards were presented—The Borg-Warner Industry Award and the Dr. Robert H. Goddard Memorial Trophy.

The Borg-Warner award went to the Missile Systems Division of the Lockheed Aircraft Corporation for its work on *Polaris* during the calendar year 1957. The Goddard trophy, presented by American Aviation Publications, Inc., went to Dr. Wernher von Braun, director of Development Operations Division, Army Ballistic Missile Agency, for his work on *Jupiter* and *Jupiter-C*. Both awards are to be presented annually.

All-told, over 600 representatives of government, industry and the press registered for the conference.

• **Panel sessions**—The first panel session discussed Contracting and Negotiation.

The panel on Government roles and responsibilities concentrated heavily on the proposed National Aeronautical and Space Administration.

The panel on Research and Development discussed the balance between privately financed and government financed R & D and other subjects in the field.

The Commercial Markets Panel agreed that there would someday be a commercial market for the missiles, rockets and space flight knowhow, but that military proficiencies had to be developed first.

The final panel, Business Forecasting, reviewed the relative positions and roles of ARPA, NASA and the three military services.

Weekly Publication of m/r Begins

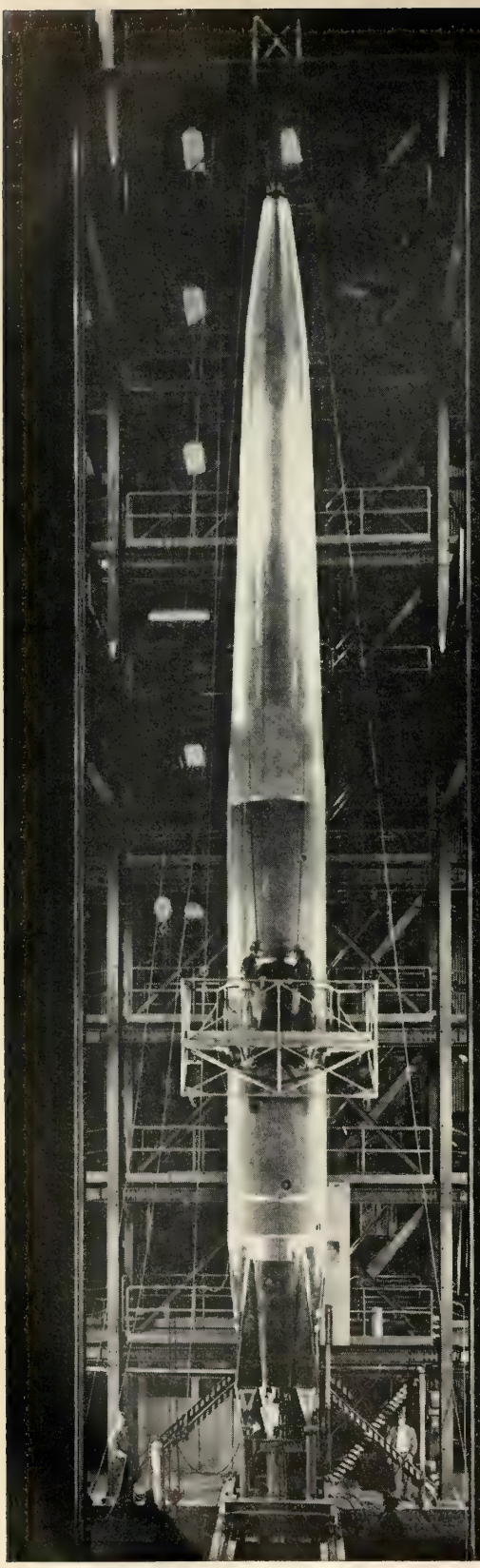
With this issue, MISSILES AND ROCKETS magazine begins a new page of its brief, but spectacular role as a major force in the creation of, and service to, the dynamic new missiles industry.

As a weekly publication, the magazine will now be placed in the hands of its subscribers every week, carrying a Monday dateline. The weekly issues will alternate between News and Business Editions (such as the current one), and larger Engineering issues, of which the July 14 issue will be the first.

The News and Business editions will contain latest news of the industry, plus regular weekly features such as the contract reports that appear on page 13 of this issue. The Engineering issues will contain news pages, contract reports, the regular editorial page, and a full complement of engineering features, picture stories, columns and the like.

The move from a monthly to a weekly frequency of publication is, of course, dictated by the fast-moving industry which the magazine serves. With new concepts being proposed almost every moment, with major changes in design and materials causing a missile to become obsolete before it has reached the production stage, with business policies of the government changing overnight, with new legislation vitally affecting the industry, a weekly news and engineering magazine devoted entirely to the industry is a vital need.

In preparation for the transition, the magazine's staff has been nearly tripled. It now employs 11 full-time editors, who are backed by six contributing editors, an eight-member advisory board, news bureaus in Los Angeles and Geneva, Switzerland, 10 news correspondents located in strategic areas of the U.S., and the full leased-wire news service of United Press International Washington News Service. In addition, the full news-gathering facilities of the 15 other American Aviation publications are available to m/r.



No other missile test lab can do all the things we can do

Take our 100-foot test tower. With it we can simulate the pressure and aerodynamic loadings that occur during the actual launching and flight of a missile.

This is just one of the many specialized facilities and tools that we have built up in the last ten years. During this decade—because of our complete responsibility for the development of a major weapon system—we have also piled up a wealth of experience in many related fields.

The upshot of this is that we can handle any project from far-out basic research to static and dynamic testing of complete airframes.

For example, we can simulate aerodynamic heating and loading at the same time...on a complete wing or a large section of fuselage. We're old hands at applying heat gradients from leading to trailing edge and spanwise. And we are equipped to compute temperature differentials, and to predict specific area temperatures.

We're completely qualified to work with any kind of metals or nonmetals; materials and processes; electrical, hydraulic and pneumatic components and systems; structures; reliability; environmental testing (including re-entry); and instrumentation.

Now we'd like to solve your problems. The tougher the better.

Please write to E. R. Schenkel, Missile Division Test Lab Manager, North American Aviation, 12214 Lakewood Blvd., Downey, Calif.

MISSILE DEVELOPMENT DIVISION

North American Aviation, Inc.



missile business

by Seabrook Hull

A "Middle-Size-Business Protective Association" has seriously been suggested as a means of combating the privileges, perquisites, and political influence of both small and really big business in the missile field. Point is—and it seems valid—that between the sheer weight of size and employment, on the one hand, and political sympathy on the other, the middle-size company in the missile business faces an unfair competitive situation . . . and is just now beginning to realize it.

A number of these companies are beginning to have the feeling that they have lost important contracts not so much because they were on the wrong technological track or because they were bidding high, but because they were neither big influential business nor small politically protected business. No conclusions this time around, but it's worth considering.

And now a word to you who are getting frustrated with your efforts to become established in the missile business. This comment comes from the recent Connecticut Missile Sales Conference at Hartford, "We don't need new contractors as much as we need better contractors." Read and note the word "better."

New sciences are always needed in the missiles, rockets and space flight business, but the basic, really important requirement is for better methods of production—how to meet an operational requirement in the most reliable manner at the lowest possible price.

For example, there is a company that has made a solid rocket motor casing with a burst strength of 293,000 psi. Another company is designing and constructing a rocket nozzle made of molded plastic, with an electro-plated chrome finish to resist high-temperature, high-velocity erosion. These may replace current methods.

Advanced Research Projects Agency has an idea which may not be so bad after all. However, ARPA has a problem: how to implement it. ARPA's idea is that very often small companies can solve specific problems in the missile and space flight field with much greater speed, with greater expediency and at less cost than large, massive administrative complexes.

This, in fact, has been demonstrated on more than one occasion—for example, the Army's IRBM *Jupiter* reentry nose cone problem, which was solved for less than 1% of the money the Air Force has expended on a similar problem. Not only that, but the AF contractors on the reentry nose cone problem are finally turning to what amounts to Army's solution.

Getting back to ARPA and its problems, the question is: How can ARPA get word to those companies that may be able to do the job?

contract awards

NAVY

By Navy Dept., Bureau of Ships:

Westinghouse Electric Corp. received $17,905,000 for reactor compartment components.

International Business Machine Corp. received $4,165,856 for high speed general purpose digital computer.

Daystrom Systems, Div. of Daystrom, Inc., received $60,573 for working breadboard model of a digital integrating and data processing system.

Computer Control Co., Inc. received $38,871 for the design, development, testing and furnishing of two developmental models of electronic counter system.

General Dynamics Corp. received $710,154 for design and engineering studies of reactor plant.

M. H. Treadwell Co., Inc. received $260,193 for investigation to prove the feasibility of reducing the height of an electrolytic oxygen generator.

Beckman Instruments, Inc. received $251,270 for atmosphere analyzer MK III.

United States Testing Co., Inc. received $400,000 for testing electronic components and undertaking various studies.

Westinghouse Electric Corp. received $11,090,000 for the design and furnishing of reactor compartment components.

Raytheon Mfg. Co. Research Div. received $182,280 for investigating design and fabricating spacistor.

Cannon Electric Co. received $74,799 for design and development of a special missile miniature high temperature multi-contact connector.

By Navy Dept., Buearu of Ordnance:

Talco Engineering Co. received $108,600 for 120-person ejection rocket catapults.

University of Virginia received $30,600 for research studies in applying laboratory techniques to study problems in high speed gas dynamics.

Universal Match Corp., Armament Div., received $75,000 for engineering services in connection with maintenance, overhaul, alteration and solving of industrial processes of missile launchers.

By Bureau of Aeronautics:

Bell and Howell Co. received $61,550 for camera missile scoring, high speed, 16 mm in accordance with specifications.

Bell Aircraft Corp. received $41,728 for development and publication of a manual for computation of aerodynamic heating effective of high speed aircraft.

American Optical Co. received $63,825 for research of prototype full pressure suit assembly consisting of helmet, neck ring, neck section and tie down system.

Mine Safety Appliances Co. received $92,241 for research of prototype full pressure suit helmet assembly.

Loral Electronics Corp. received $142,280 for developmental models of ground track plotter.

By Dept. of the Navy, Office of Naval Research:

University of California received $35,000 for research in digital components and systems.

Dunlap and Associates, Inc. received $25,168 for research and survey of operational environment factors which effect crew efficiency in Polaris weapons systems.

Polytechnic Institute of Brooklyn received $42,180 for research to investigate electron transfer process.

University of Chicago received $74,576 for fundamental investigations of the thermodynamic transport and structural properties of both solid and liquid metallic solutions.

University of Oklahoma Research Institute received $25,854 for research on grain boundary diffusion.

California Institute of Technology received $35,000 for research on the fundamental aspects of materials pertaining to nuclear engineering.

Leland Standford, Jr. University received $30,000 for theoretical and experimental research in the area of self-adaptive control



Maj. Gen. B. A. Schriever and RAF Air Chief H. Broadhurst examine model.

Thor To Be Operational In England by End of '58

The *Thor* and its tactical ground support equipment will be operational in the United Kingdom by the end of this year, according to the Air Force Ballistic Missile Division.

Air Chief Marshal Sir Harry Broadhurst, Commander-in-Chief of the RAF Bomber Command, recently visited the Air Force Ballistic Missile Division for a detailed briefing on the status of the *Thor*. The IRBM's will be assigned to elements of Air Marshal Broadhurst's Bomber Command.

The briefing was conducted by Maj. Gen. Bernard A. Schriever, Commander of AFBMD.



GRASSHOPPER—Reaction Motors Division of Thiokol Chemical Co. has come up with this rocket-powered jump belt which will enable soldiers to leap distances up to 20 ft. carrying equipment to 30% of their own weight.

systems.

Lowell Observatory received $36,800 for research on three-color photometry of galactic clusters.

University of Michigan received $40,000 for research of acoustics of structures.

Northwestern University received $40,000 for research on structures and properties of solid solutions.

Wayne State University received $40,000 for research in automatic mechanical translation.

Indiana University received $30,780 for research on the mechanism of hydrogen transfer in biological energy-yielding reactions.

ARMY

By San Francisco Ordnance District:

Aerojet-General Corp. received $65,420 for ST-90 test vehicles rocket engine, igniter.

Stanford Research Institute received $54,525 for standard analytic methods for cost, and to schedule budget control over missile system programs; $25,000 to study aspects of radiating antenna systems research; $99,989 for propagation studies (guided missiles & related equipment).

University of California received $25,480 for fundamental investigation of surface ablation during convection heating research.

Ampex Corp. received $150,880 for recorder reproducer system.

Food Machinery & Chemical Corp. received $140,000 for design of prototype and pilots of chassis for Vigilante "B" program.

By New York Ordnance District:

Acoustica Associates, Inc. received $27,855 for control unit #CU-1CA and probe assembly, liquid level sensor #AT-26.

Air Reduction Co., of Air Reduction Co., Inc. received $82,650 for developing cumferential welding fixture for *Jupiter* missile center sections.

Block Instrument Corp. received $35,000 for Phase I feasibility study leading to design of T35 ballistic computer.

Western Electric Co. Inc. received $511,240 for production engineering services for the preparation of miscellaneous ordnance documentation for the *Nike-Hercules* guided missile system.

Peat, Marwick, Mitchell & Co. received $63,227 for study of the present accounting system at ABMA, and design of a complete budgeting, funding and accounting system on an accural basis.

Federal Telecommunication Labs, Div. of International Telephone & Telegraph Corp., received $49,376 for study of high resolution radar.

Ford Instrument Co. received $398,802 for design and development of inertial devices.

Air Reduction Sales Co. received $71,857 for development and fabrication of circumferential welding fixture for *Jupiter* missile center sections.

Bulova Research & Development Laboratories, Inc. received $91,073 for accelerometer monitors for *Jupiter* guidance system.

By Pittsburgh Ordnance District:

National Electric Products Corp. received $93,849 for research and development for supplies and services required for the design of modified T52 jato metal parts assembly.

Combustion & Explosives Research, Inc. received $29,885 for research and study on the explosive hazards of liquid propellants.

By Philadelphia Ordnance District:

Western Electric Co. received 14 contracts totaling $4,874,805 for *Nike* spare parts and components.

General Development Corp. received $74,985 for development of ballistics measurement equipment.

Duke University received $25,304 for research study, "Experiment at Liquid Helium Temperatures."

Radio Corp. of America, Defense Electronic Products, received $449,980 for down range measurements program.

Hoover Electronics Co. received $99,922 for engineering study on improvement of manufacturing techniques for guided missile wiring harnesses.

Philco Corp. received $93,647 for components to be used in telemetering and tracking of satellites.

University of N.C. received $66,100 for study of spin-stabilized rockets during burning.

Western Electric Co. received five contracts totaling $527,999 for *Nike* spare parts and components.

Askania-Werke, A. G., U.S. branch office, received $97,740 for new KTH-53 cinetheodolities.

AIR FORCE

By AFMTC, ARDC:

Radiation, Inc. received $50,000 for increase in funds.

Technitrol Engineering Co. received $72,116 for increase in funds.

Alfred Hofmann & Co. received $92,755 for eight additional inclosures, ballistic camera.

The Perkin-Elmer Corp. received $130,736 for installation of ROTI Mark 11.

Milgo Electronics Corp. received $37,974 for digital-to-analog converter for impact prediction.

Technical Engineering Co. received $35,680 for increase in funds.

Consolidated Electrodynamics Corp. received $57,060 for magnetic tape recorder.

Natural Gas Co. Of Fla., Indian River Gas Co., received $26,278 for increase in funds.

By AFFTC, Edwards AFB:

Electronic Engineering Co. of Calif. received $62,543 for data transmission system; $99,956 for time code and control pulse generator system.

Hycon Eastern, Inc. received $26,550 for digital timing generator.

Minnesota Mining & Mfg. Co., Mincom Div., received $45,344 for tape, magnetic instrumentation recording.

Westvaco Chlor-Alkalis Div., Food Machinery and Chemical Corp., received $39,200 for mixed U-deta 60% fuel.

Sandberg-Serrell Corp. received $57,090 for study of high altitude test chamber diffuser.

Stanford Research Institute received $87,677 for advance study of the high speed track vehicle shock and vibration problem.

Dynamic Research Inc. received $46,300 for testing and installing high pressure nitrogen booster system.

By AFMDC, ARDC:

Northrop Aircraft, Inc., Northrop Division, received $69,068 for support services and parts for supersonic windblast tests, effects of supersonic wind blast on human tolerance.

Winzen Research Inc., received $99,600 for modification of balloon capsule system and "Man High" III flight.

MB Manufacturing Co. received $89,665 for electromagnetic vibration system, for use by the stratospheric branch high altitude test division.

Arthur D. Little, Inc. received $81,127 for study of alkali metals as propellants.

Land Air Inc. received $103,110 for range instrumentation.

By AF Cambridge Research Center, ARDC:

Armour Research Foundation of Ill., received $41,936 for development of an ozone analyzer.

Philco Corp. received $94,089 for investigation of the physical limitations upon current gain beta.

The Perkin-Elmer Corp. received $30,000 for radiation measurement with Roti.

Massachusetts Institute of Technology received $75,000 for research toward solution of fundamental electronic scanning and radar problems.

Stanford Research Institute received $95,273 for research of ECM antennas and components.

William M. Wolf Co. received $98,420 for design studies and analytical investigation on the configuration of centralized and forecasting operations.

The Ohio State University Research Foundation received $49,488 for investigations on bi-static reflection characteristics of shaped objects.

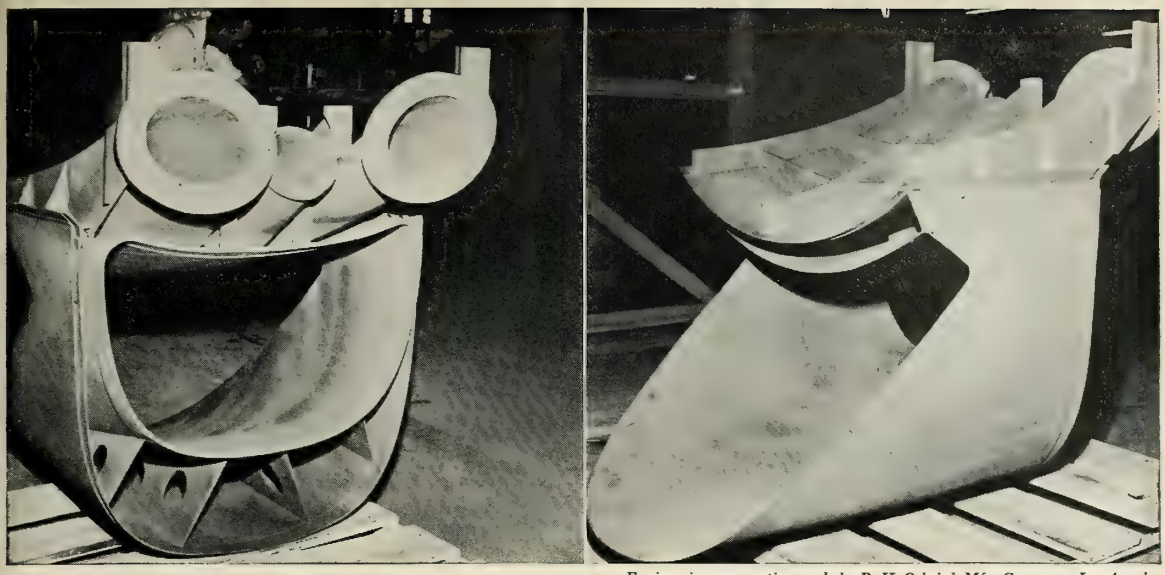
Sylvania Electric Products, Inc. received $58,925 for investigation on non-linear phenomena.

Westinghouse Electric Corp. received $51,197 for study of pulse transmission.

Harvard College received $35,270 for research directed toward study of planetary atmospheres.

The University of Chicago received $61,000 for studies on planetary atmospheres and lunar surfaces.

The Pennsylvania State University received $35,000 for research on the structure of the lower ionosphere by means of a sweep frequency technique.



Engine air scoop casting made by R. H. Osbrink Mfg. Company, Los Angeles

MAGNESIUM "SUGAR SCOOP" HELPS REGULUS II BREATHE

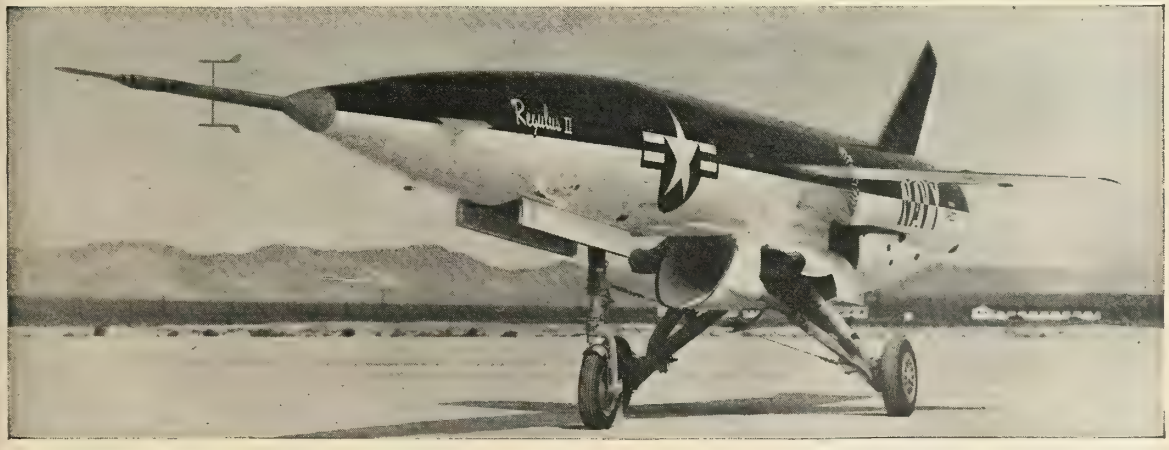
Huge thin-wall magnesium casting satisfies appetite for air

At supersonic speeds more than ten miles above the earth, Chance Vought Aircraft's Regulus II consumes enormous quantities of air through a 150 lb. magnesium casting.

This complex, close tolerance magnesium casting supplies air for the Regulus' powerful J-79 jet engine. It also provides ducting for boundary layer control and for air conditioning. Nominal thickness on walls and webs is 0.24 inch and the solid leading edge tapers to a 0.015 inch cast radius. Casting tolerance is + or −0.03 inch on dimensions up to 12 inches, with an additional + or −0.002 inch per inch on dimensions above that. That's real casting accuracy!

This air scoop is an excellent example of the versatility and usefulness of magnesium alloy castings in aircraft design. Thin-wall casting designs can be produced in magnesium to replace complicated, costly fabrications involving several production operations.

For more information about magnesium sand castings and their use in aircraft design, contact your nearest magnesium foundry or Dow sales office.





MAGNESIUM DESIGN, a 235-page handbook, discusses in detail: properties, structural design, product design including castings and mill products, fabrication and finishing. Large section of tables on properties, sizes, tolerances, etc. For your copy contact a Dow sales office or write to THE DOW CHEMICAL COMPANY, Midland, Michigan, Department MA 1463L.

YOU CAN DEPEND ON DOW



STRAIGHT TALK TO ENGINEERS

from Donald W. Douglas, Jr.

President, Douglas Aircraft Company

I'm sure you've heard about Douglas projects like Thor, Nike-Ajax, Nike-Hercules, Nike-Zeus, Honest John, Genie and Sparrow. While these are among the most important defense programs in our nation today, future planning is moving into even more stimulating areas.

Working as we are on the problems of space flight and at the very borderline of the unknown, engineering excellence in all fields is essential. For you engineers who can help us move forward, opportunities are almost as limitless as space itself.

If you thrive on tough problems – and there are many – we'd like to discuss a future at Douglas with you.

Please write to Mr. C. C. LaVene
Douglas Aircraft Company, Box 620-R
Santa Monica, California



UNDER CONTINUOUS STRESS:

Creep can ruin your best designs!

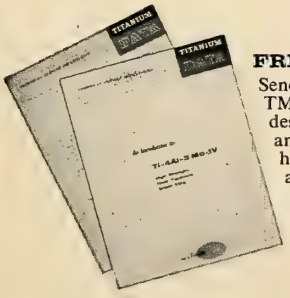
Whether your creep problem is sagging socks or stretching struts, the result is pretty much the same: Things don't hold their shape the way they should.

Garters we don't have. But we do have new titanium alloys which offer a rare combination of excellent creep resistance plus light weight (density 0.163 lb/cu. in.), great tensile strengths (to 175,000 psi), and outstanding corrosion resistance.

In bar and forging stock, there's Ti-8A1-1Mo-1V. Its short-time elevated temperature properties are similar to Ti-6A1-4V, one of the most widely used titanium alloys. Yet "8-1-1" offers as much as a tenfold increase in creep strength between 600° F, and 1000° F. This means that, for an equivalent stress level, Ti-8A1-1Mo-1V raises the effective operating temperature *150° F.*

In sheet stock, there's Ti-4A1-3Mo-1V, which offers excellent formability because of good tensile elongation, bend ductility, and low yield strength in the solution-treated condition. Yet this alloy can be heat-treated to strengths of 175,000 psi.

At Toronto, Ohio, Titanium Metals Corporation of America is now operating the world's only plant designed and instrumented solely for rolling and forging titanium. With this facility, TMCA can furnish you the best quality metal, on the fastest delivery schedule, at the lowest possible price in the industry today.



FREE:
Send for TMCA Data Sheets describing physical and mechanical properties, heat treatment methods, and other useful information about the new creep-resistant alloys.

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Astrodyne Rocket Boosts F-100D

The close working arrangement of Astrodyne, a unit of Phillips Petroleum, and North American Aviation was shown recently at Edwards AFB, Calif. A combat loaded Super Sabre was successfully blasted off a zero-length launcher with the aid of a 130,000 lb. thrust solid propellant rocket.

The high thrust rocket, presumably an ammonium nitrate-synthetic rubber propellant combination, blasted off with a 40 ft. long flame, spewing forth clouds of black and gray smoke. The jet was accelerated to 275 miles per hour in less than four seconds.

GE Test Facility for Missile Radar Underway

Work is underway on a new test facility for the ballistic missile radar system being built by the General Electric Co.

The new facility will be used in engineering, developing and testing as well as for the training of personnel for installation and operation of the radar system. Construction is now going on at GE's Systems Center, Syracuse, N.Y.

Construction Underway for *Snark, Polaris* and Plato

An electronic test site is being developed for the Plato anti-missile missile system project, according to Sylvania Electric Products Inc. The site, located at Ft. Devens, Mass. Army Base, will not be used for missile firing.

Elsewhere, construction is underway on the U.S.'s first operational intercontinental missile launching station. The facility, to be manned by the Strategic Air Command, will be used for launching the *Snark*. The station is at Presque Isle AFB, Maine.

Navy has authorized additional construction at the *Polaris* development facility at Lockheed Missile Systems Division.

Man Survives Tolerance Record of 83 G's

Capt. E. L. Beeding, Jr. survived an 83 G loading at the U.S. Air Force Missile Development Center, Alamogordo, N.M. The human tolerance test was conducted at the Center's aeromedical field laboratory.

Captain Beeding was seated in an upright and backward facing position on a research sled. The test took place on the 120-ft. long "Daisy" track. Total force on the officer's body was equivalent to 11,620 lbs. For one-tenth of a second, he experienced an increase of 5,000 G.



propulsion engineering

by Alfred J. Zaehringer

Best bets on boron blends: Olin Mathieson's HEF-2 is probably an ethylated pentaborane, while HEF-2 may be an alkylated decaborane; HEF-5 may be butyl substituted. Callery's HiCal may be alykl derivatives of the lower borons such as diborane.

Liquid hydrogen is moving up fast as a rocket fuel. Present small scale tests with hydrogen are using LOX, but several stands are going up for liquid fluorine. If tests with hydrogen-fluorine motors continue to be successful, there will be a need for ultra low temperature pumps, valves, seals, containers plus scrubbers for absorbing HF exhausts.

UDMH-Di Tri was likely the fuel for *Jupiter*-C. A replacement for alcohol, the mixture is known as Hydyne and has a reported composition of 60% unsymmetrical dimethylhydrazine and 40% diethylene triamine.

Production of hydrogen peroxide is high, but primary propulsion use is low. Estimated U.S. production for this year is 27,000 tons, but only a very small fraction of this goes into rockets. Most peroxide use is for auxiliary power on large liquid rockets. Other liquid and solid propellants continue to gain for APU use.

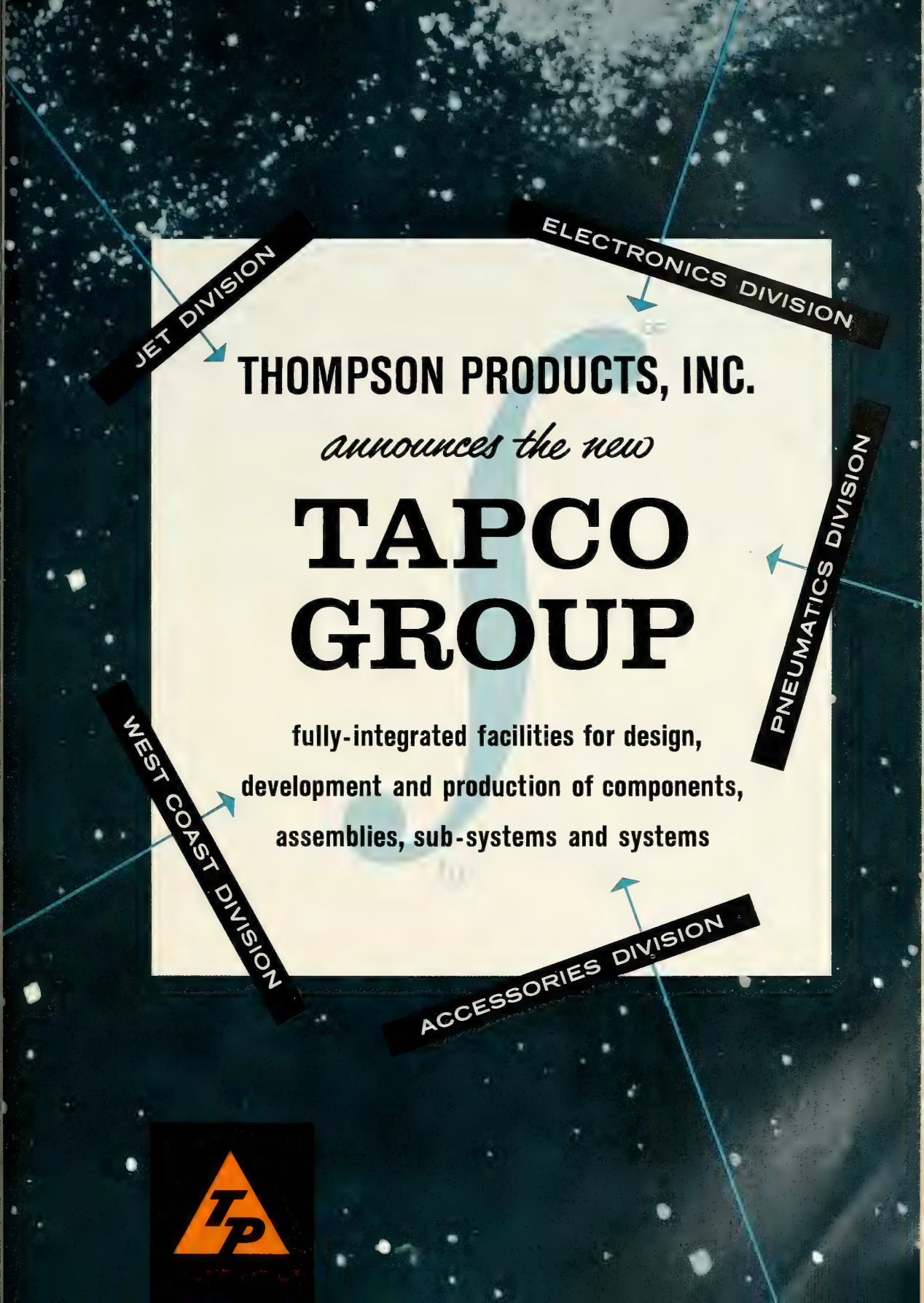
Newest oxidant: chlorine nitrate. $ClNO_3$ has been prepared at the University of Munich. Reaction is violent with inorganics and organics. This oxidizer may potentially be more valuable as a new nitrogen introducer for the synthesis of new oxidants or monopropellants.

Heavy elements will make the best ion propellants. According to a study program conducted by Rocketdyne for the Air Force, heavy positively charged ions make the best propellant. At the same voltage, $(U_{238})^+$ ions will produce over fifteen times the thrust that can be obtained from $(H)^+$ hydrogen ions. Best thrust-to-weight ratio that can be expected is less than 10^{-4} G. Minimum voltage needed for an ion rocket is estimated at about 12,000 volts.

Ceramic-coated rocket engines will see great advancement. Super refractories in combination with new application techniques will rely heavily on the use of lithia as a flux. Gulton Industries has found that this material improves adhesion, impact resistance and thermal expansion.

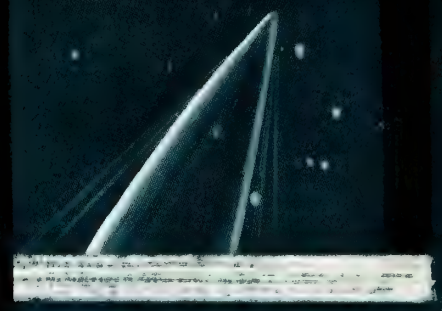
Free radicals are not yet practical when considering thrust developed by a given engine and system weight. Aerojet-General figures that free radical solid or liquid propulsion systems do not appear promising.

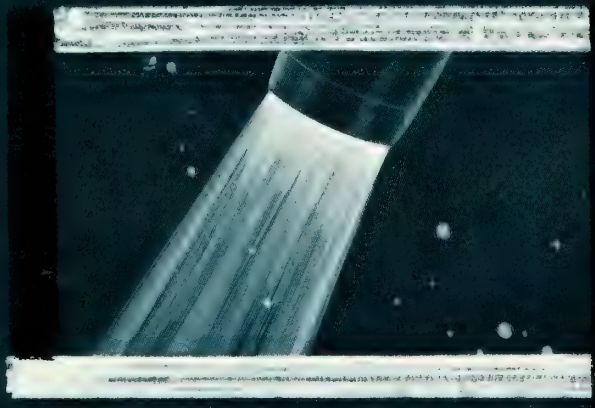
Replacements for ammonium nitrate? Considerable research work is underway for evolving a more powerful solid oxidant. Present work stresses more oxygen content, low molecular weight exhaust products, and low combustion temperatures. Most likely prospects now include urea nitrate, acyl nitrates, and oxygen-substituted nitrogen compounds.


JET DIVISION
ELECTRONICS DIVISION
THOMPSON PRODUCTS, INC.
announces the new
TAPCO
GROUP
PNEUMATICS DIVISION
fully-integrated facilities for design,
development and production of components,
assemblies, sub-systems and systems
WEST COAST DIVISION
ACCESSORIES DIVISION
TP

NEW Tapco Group offers integrated facilities for...

STRUCTURES

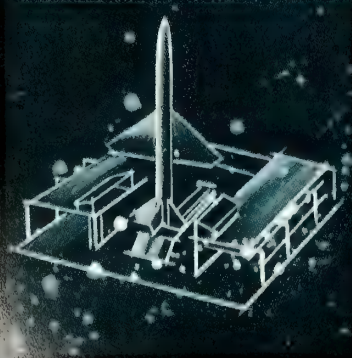




PROPULSION

CONTROL SYSTEMS





GROUND-SUPPORT EQUIPMENT

Missile envelopes, air frames, pressure vessels, and other structures for every purpose can be designed, prototyped, built and tested within the Tapco Group. "Flotrusion", an unusual method of extruding steel tubing to produce structural parts with integral end features, has been developed by the Tapco Group.

Components and assemblies for main propulsion systems to operate on any liquid or solid propellant, and for auxiliary power units to provide electric, mechanical, pneumatic or hydraulic power are within the capabilities and experience of the Tapco Group. In addition, much experience with nuclear power has been built up by the Tapco Group.

Electronic devices, as well as hydraulic, pneumatic, and mechanical controls and actuators, are an important segment of the Tapco Group's activity. The men and the facilities to coordinate all units into a complete system are ready now to research and produce systems of all types and complexity.

The ground-support components for any project can be supplied in the complete services and facilities offered by the Tapco Group. These include ground-support control and guidance devices, shelters and their activating mechanisms, transporting devices, and all types of ground-support mechanisms and structures.

TAPCO GROUP

consisting of Accessories, Jet, Electronics, Pneumatics and West Coast Divisions

Thompson Products, Inc. CLEVELAND 17, OHIO

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includes work in these fields...for these projects...

ELECTRONICS	TERRIER
NUCLEONICS	HUSTLER
AIR-TRACKING SYSTEMS	BOMARC
AIRCRAFT AND MISSILE CONTROL DEVICES	THOR
FUEL SYSTEMS	BULL PUP
OPERATIONS SEQUENCING	JUPITER C
SECONDARY AND AUXILIARY POWER SYSTEMS	NIKE-HERCULES
COMPUTER-DEVELOPED DESIGNS	707
METALLURGY AND FABRICATION OF UNUSUAL METALS	ATLAS
HEAT-TREATING FACILITIES	PERSHING

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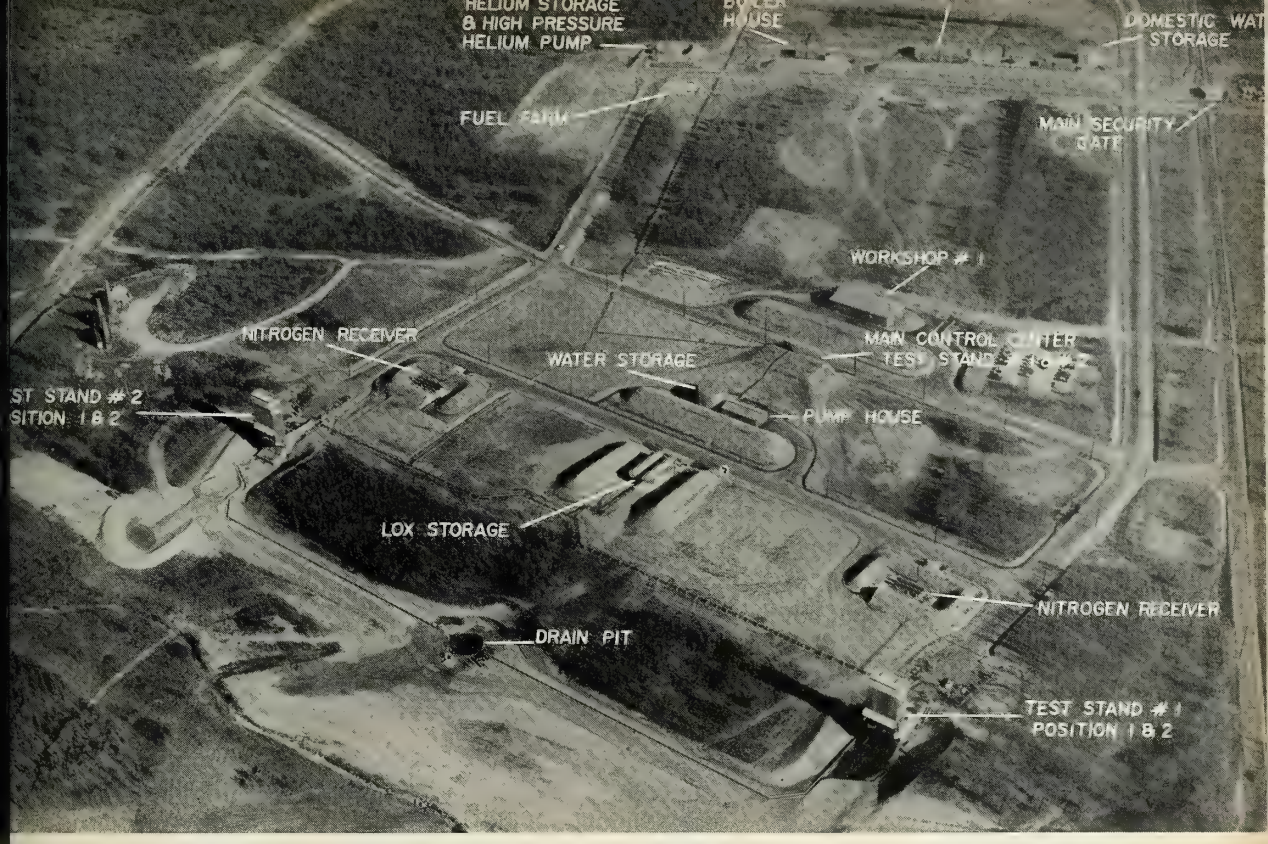
$368 million in annual sales by Thompson Products, Inc., is proof of the financial responsibility and integrity of the Tapco Group to develop, produce, and deliver any project or part of a project entrusted to it.

TP

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ROCKETDYNE NEOSHO'S *THOR* thrust chamber test facilities cover 200 acres of Missouri hills.

Thor Engine Reaches Production Tests



***THOR* THRUST CHAMBERS are calibrated with 1,000 psi water flow tests before leaving the fabrication area.**

by Norman L. Baker

NEOSHO, MO.—For the past few weeks, the low, rolling hills surrounding this small Ozark community have reverberated to the roar of the United States' largest rocket engines undergoing static tests at Rocketdyne's facilities a few miles away. Recently ordered into production, these engines, which are now rolling off the assembly lines, will power the Air Force's *Thor* IRBM.

Rocketdyne Neosho's development from initial facilities layout to delivery of the first production engine is a story characterized by the same demanding urgency as development of the intermediate range ballistic missile itself.

Seven months after DOD approval in November 1955, Rocketdyne delivered the first model of an entirely new engine system. Three months later, the first production model was delivered—three months before the first missile launchings in January, 1957.

A simplified and improved model of this new high thrust engine is now in quantity production and testing—little more than a year after the ground was broken for the 200-acre test site.

The 228,000 sq. ft. manufacturing plant and nearby supporting test facilities is located on 1,785 acres of the old Ft. Crowder reservation lands. The plant now employs about 1,500—almost double the employment figure of six months ago.

Construction on the facility—started by Aerojet—was taken over by North American when the Air Force decided that Rocketdyne would operate the plant. The test area is located about two miles from the administration and production areas.

Major items of the test complex are the two high-thrust test stands, each capable of handling two engines. The stands are operated from a reinforced concrete control building equipped with batteries of electronic recorders and remote TV receivers.

Extensive earth revetments provide protection for personnel and isolate propellant and test stand areas. The



Think small

Mechanical brains for missiles must be as tough and tiny as possible . . . a design problem that calls for experts skilled in both electronic computers and miniaturization.

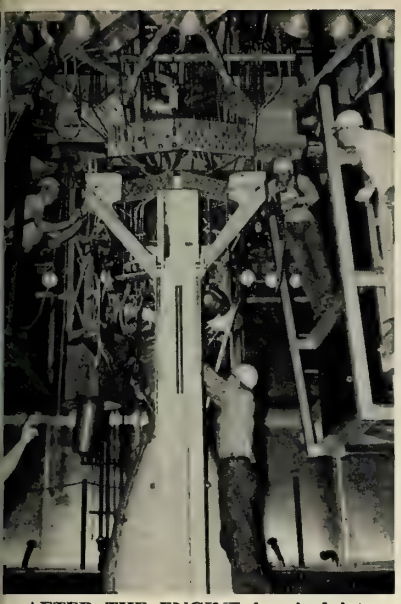
ARMA's computer group has shrunk a digital computer module until it's the size shown above . . . a feat comparable to squeezing the contents of a steamer trunk into a cigarette package.

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AFTER THE ENGINE is raised into a vertical position by the transporter trailer, the stand crew attaches the chamber to the thrust measuring brackets, and connects the many hydraulic and instrumentation lines and tubes of the stand system.

test area has its own water supply and distribution system. Engine fuel is stored on the base while the liquid oxygen is trucked in from Tulsa, Okla.

A major portion of the engines are hot tested for cycles ranging from 15 to 30 seconds. After several engines have been tested, the test stand is recalibrated with a 110-second run which approximates the total burning time for flight operations. The entire propulsion system, less the two vernier engines used on the *Thor* for added control, is mounted for each test. Propellants are pumped into the system by the power plant's gas generator system.

The engines are subjected to a hydraulic flow test before transportation to the test area. Water, under 1000 psi pressure, is forced through the more than 300 nickel tubes which make up the walls of the regenerative cooled thrust chamber. The tubes are secured in position by soldering, and held together with steel bands, welded at intervals to the outside of the chamber for rigidity and absorption of internal pressures. The water tests locate any holes accidentally produced by the welding operations.

Gas generators and vernier engines for the *Thor* are tested at a separate facility that has been in operation since the first of the year.

Test facilities currently operating on a two-shift status, are reported to be adequate for the present production schedule.



ENGINE IS JOCKEYED into position on test stand floor for attachment to mounting brackets prior to a captive test. The hinged platform, background, is raised when the engine is in place to give work area for stand crew during final operation.

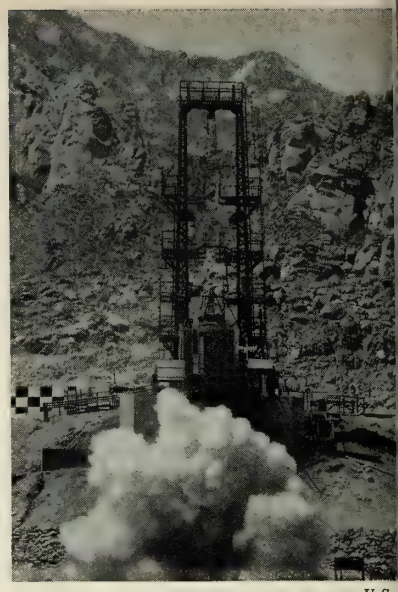


PREFIRING CHECKOUTS are made from this remote control room. Several hours are sometimes involved in the countdown check. Hot firings are observed with television receivers and recorded by banks of instruments within the control room.



START OF HOT FIRING of *Thor* engine on test stand #1. Steam, formed by cooling the hot gases of the engine and gas generator, soon blankets the surrounding area. Visual observation of the firings are made from a point several hundred yards distant.

Million-Pound-Thrust Stand Planned at Army's White Sands



U.S.

An m/r staff report

WHITE SANDS, N.M.—U.S. Army Ordnance has revealed that one of its 300,000 lb. thrust solid propellant rocket test stands will be enlarged to accommodate motors having thrust levels up to, and including, one million pounds of thrust.

(There are several other million pound thrust facilities, including those located at ABMA Huntsville, Aerojet, Rocketdyne, Thiokol, Utah.)

In addition, the Army has given m/r an exclusive view of its expanding rocket engine test capabilities at White Sands Proving Ground, N.M. Such a view indicates that the Army plans to keep in the high thrust rocket engine race now shaping up.

Three separate testing facilities are provided to test propellants and performance of various missile motors under all known conditions expected in flight. These facilities are equipped to perform developmental, engineering, and acceptance tests on both solid and liquid fuel propulsion systems, subsystems, and components.

The three major static test facilities are:

1. The 500,000 lb. thrust facility.
2. The 300,000 lb. thrust solid propellant facilities.
3. The 100,000 lb. thrust facility.

The rocket powerplant test facilities at WSPG are under the Propulsion Branch of Electro-Mechanical Laboratories, a division of Ordnance Mission. The Propulsion Branch is headed by a civilian engineer, Lowell Randall.

• **Facility operation**—The 500,000 lb. thrust test facility is one of the largest in the world, and presently can test motors for any known missile or rocket. Dug into solid rock, the 500,000 lb. test facility is built into unfaulted granite on the east face of a spur of the Organ Mountains, 4,400 ft. above sea level and 200 ft. above the floor of the Tularosa Basin.

A concrete flame pit extends 60 ft. straight down the side of the mountain, and 3,000 gallons of water per minute are used to quench the rocket exhaust. This is a liquid propellant rocket stand which can accept a test package of up to eight ft. in diameter.

Designed, and under construction from 1947 to 1950, the tower was originally built to fire 500,000 lb. motors at a 60° angle. It was rebuilt to handle 125,000 lb. in a vertical plane, with a maximum motor package measuring eight ft. by eight ft. Four load cells are used to gage thrusts.

The control room is built below ground and is carved into the solid rock mountain. Four observation windows in the east wall face angular mirrors which allow indirect viewing of the test. The 936 sq. ft. control room is built in a T-configuration, with observational area and control console contained in a forward section.

Behind the control area is a huge instrumentation room which contains the banks of recorders. Included in the instrumentation are five remote camera circuits to provide recorded visual information at various angles.

Equipment is mounted on the tower to handle rocket motors or a complete missile. Hoists are installed on the tower. An elevator rising 45 ft. above the flame pit has a 2,500 lb. capacity.

• **Thrust equipment**—The 300,000 lb. thrust solid propellant test facilities are much different in design from the 500,000 lb. thrust liquid rocket facility described above. The 300,000 lb. facility consists of four concrete test bays, one open test pad, and a concrete control and instrumentation blockhouse protected by an earth embankment.

Two of these bays are designed to handle thrusts up to and including 300,000 lbs. The other two bays are equipped to handle thrusts up to 5,000 lbs., while the large open test pad has provisions for mounting units up to 100,000 lbs. thrust.

Each bay is 43 ft. deep and 25 ft. wide, and enclosed on three sides by 12 in. reinforced concrete walls 11 ft. high. The thrust plates mounted in concrete are in the center of the bays. Any unit up to 16 ft. in length may be clamped down in the bay.

Located directly between the two pairs of test bays is a 50-ft. square reinforced concrete open pad into which portable thrust mounts can be anchored. The thrust mount is removable so that equipment can be tested within the bays if desired.

A blockhouse, containing substantially the same instrumentation and electronic facilities as the one for the 500,000 lb. thrust test facility, is located 150 ft. behind the test bays.

The White Sands solid propellant rocket motor test facilities are equipped to handle about 30 large motors per week and over 50 small motors per week on a continuous basis. Plans are now for enlarging one of the 300,000 lb. solid propellant stands to handle one million pounds thrust.

A 10,000 lb. test facility was partially destroyed by a propellant explosion late in 1955. It is to be rebuilt with a 40,000 lb. thrust capacity.

• **Static firing facility**—The last of the three separate static test facilities is the 100,000 lb. thrust facility. This is used for static firing of liquid propellant missiles, or missile systems in support of contractor and engineering user research. The facility is also used for acceptance tests and the gathering of associated operational data.

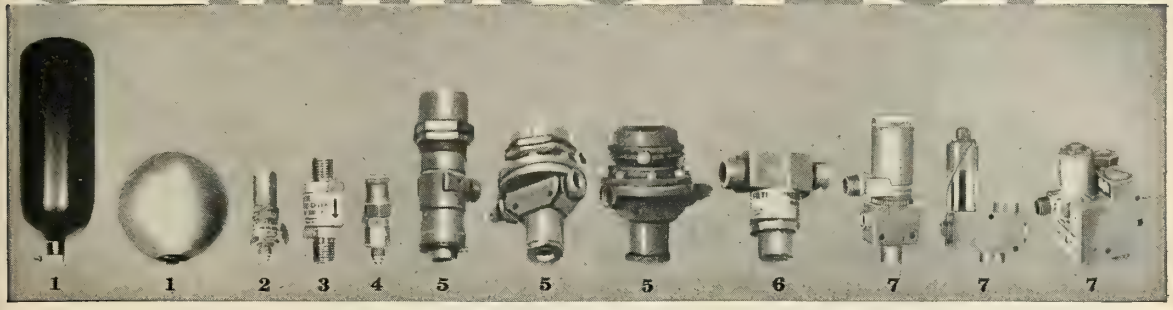
The facility was constructed in 1946 and used to static fire the German V-2 missile prior to flight tests during 1946 to 1949.

In 1956 an outrigger mount was added to this test stand to static fire the *Corporal* rocket motor independent of the missile itself, and at any angle between the vertical and horizontal positions.

Maximum test packages, including the missile itself, measuring eight ft. in diameter and 500 ft. high, can be fitted into the existing tower for vertical test firing.

The propulsion engineers and technicians assigned to the three facilities are all highly trained specialists. Frank Schultheis, civilian Army engineer, is chief of the static test section. In charge of the 500,000 lb. thrust facility is Carlyle E. Roberts. Alvin E. Howard heads the 300,000 lb. facilities. In charge of the 100,000 lb. test stand is John E. Durnin.

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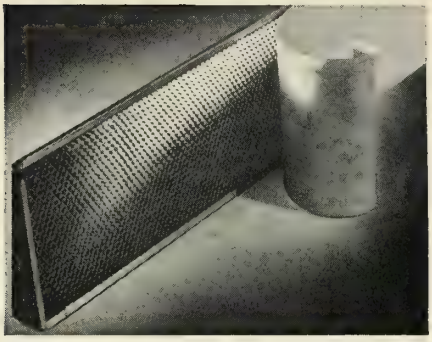
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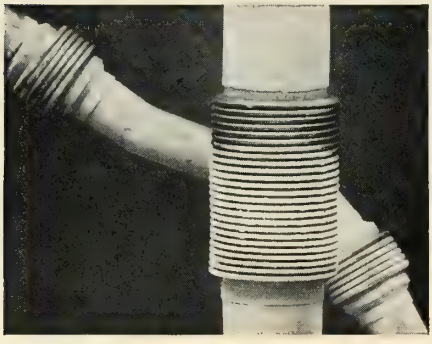
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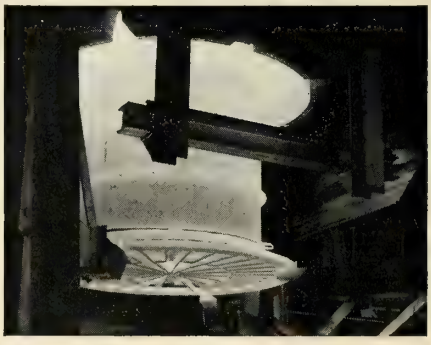
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Dr. Nicholas A. Begovich, specialist in electronic scanning radar and landing and approach systems, has been appointed director of engineering of Hughes Aircraft Co.'s ground systems group. Other recent Hughes appointments include: **Dr. William T. Clary, Jr.** as head of the systems analysis department; **John W. Bozeman,** director of the data processing laboratory; **Robert Polkinghorn,** director of the radar laboratory; and **Samuel Langberg,** head of engineering services department. All appointments are under Dr. Begovich.

Dr. Jason L. Saunderson, vice president, Chemical Instrument Engineering of Baird-Atomic, Inc. of Cambridge, Mass., has been awarded an Honorary Doctor of Science degree by Morningside College in Sioux City, Iowa.

Bruce W. Kinney has been appointed quality control supervisor of Circuit Instruments, Inc., a subsidiary of International Resistance Co. **George T. Brent** has been appointed chief engineer.

W. S. Bobiler has been named chief engineer, Detroit activity of the Aero Hydraulics Division, Vickers Inc. He formerly was engineering section head for the component development section.



Kenneth M. Lord has been appointed director of engineering in the Electronic Division of Stromberg-Carlson, the division of General Dynamics Corp. He will have charge of all engineering activities in the company's Electronics Division, which manufactures a variety of equipment for civilian and military use.

Dr. Adolph Edward Palty was recently made supervisor, Alloy Development and Evaluation, of the Utica Metals Division, Kelsey-Hayes Co. He is the author of several technical papers on metallurgy.

Col. William S. Evans, public relations officer, has been named director of Information Services at the Air Research and Development Command, Andrews Air Force Base, Md. He was formerly information services officer for the air weapon research and testing installations at ARDC's Air Proving Ground Center, Fla.

Joseph B. Elliott, formerly executive vice president and general manager, has been elected president of Tele-Dynamics Inc. **George C. Liacouras** has been elected treasurer of Tele-Dynamics.

Dr. William H. Duerig was appointed vice president in charge of research and engineering by Midwestern Instruments, Inc.

Dr. Joseph C. Patrick, discoverer and pioneer in the production of Thiokol oil-resistant synthetic rubber, has won the 1958 Charles Goodyear Medal, highest honor in rubber chemistry.

Frank Roodman has been appointed as the Austin's Company's engineering coordinator for missile projects.

John H. Reber and **A. K. Schiefner** were named as officers of the Instrument Corp. of Fla. Mr. Reber, formerly executive engineer, is now vice-president of Electronics Division. Mr. Schiefner, who was director of optics division, is now president of Optics Division.

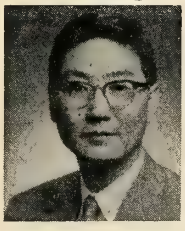


John L. Devitt was named chief engineer of the Electro Chemical division of the Frank R. Cook Co. He will be responsible for design, development, quality control and service engineering of the company's miniature battery program, used in many of the U.S. missile programs to furnish in-flight electrical power.

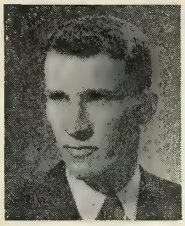
M. Lee Rice has been elected vice president of Atlantic Research Corp. He had made significant contributions to the field of rocket, missile and solid propellant propulsion and ballistics.

Dr. William C. Cooley has now become assistant program engineer on the Rover program, the research activity aimed at achievement of a nuclear rocket engine now underway at Rocketdyne.

I. Nevin Palley has been promoted to senior vice president by Temco Aircraft Corp. and **Robert E. Galer** to vice president.



Dr. Kuang Lu Cheng has been appointed Associate Director of Research, Utica Metals Division, Kelsey-Hayes Co. His major activities have been the development of special analytical processes and the production of pure elements.



Edward J. Cousin has been appointed manager of space and missile programs for Allen B. DuMont Laboratories, Inc. He will be responsible for the planning and development of defense and military electronic programs in the missile and astronautic fields.

Robert E. Kemelhor has been named manager of future product planning and development for both Pesco Products and Wooster Divisions of Borg-Warner Corp. He will direct supplementary product development programs to increase diversification at both divisions.

Dr. C. L. Register has become manager, ballistic missile division, at Burroughs Research Center, Paoli, Pa. Three new positions at the Center are: **U. C. S. Dilks,** formerly manager, research division, is new associate director-commercial products; **Edward Lohse,** former manager, ballistic missile division, is new associate director-defense products. **J. H. Howard** has been promoted to manager, research and development division.

Dan W. Burns has been elected president of the Hufford Corp., a subsidiary of the Siegler Corp. He succeeds **Merrill L. Bengtson,** who is chairman of the executive management committee.



Herbert C. Cress has been appointed to the newly created position of vice president and works manager by Ford Instrument Co., division of Sperry Rand Corp. He was formerly with the Sperry Farragut Co., Division of Sperry Rand Co., where he was vice president for operations.

Col. Paul A. Campbell has returned to the School of Aviation Medicine, USAF, Randolph AFB, Texas, to take charge of an expanding space medicine division. Col. Campbell was formerly with the Office of Scientific Research of the Air Force, where he has carried on medical studies in astronautics for the past two years. The new division of space medicine, which Col. Campbell heads, is an extension of the internationally known department of space medicine that Dr. Hubertus Strughold created at the School in 1949.



big coupling for hot tailpipes

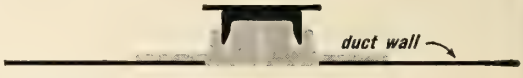
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Test data: Model illustrated is tested to 15G's with tail pipe attached, and at temperatures to 900°F. Vibration requirements of MIL-E-5272A are met.

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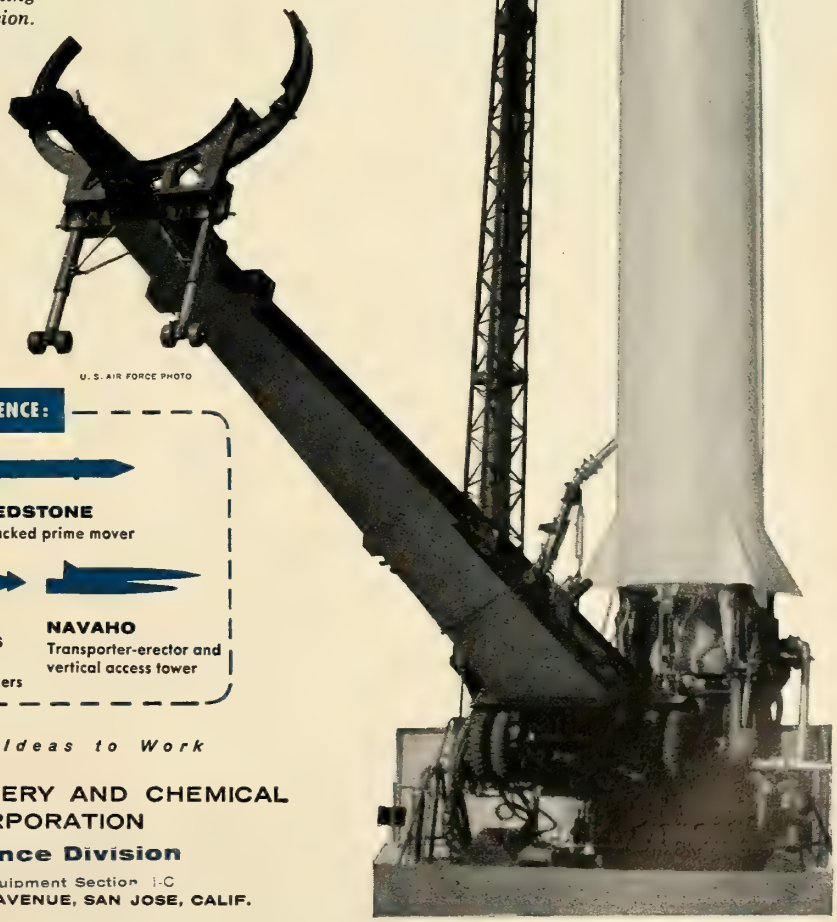
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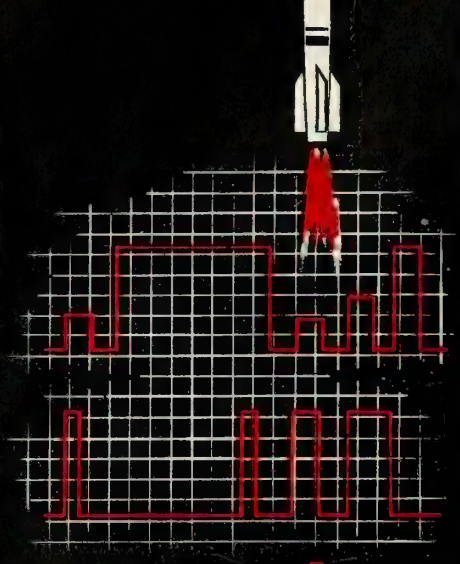
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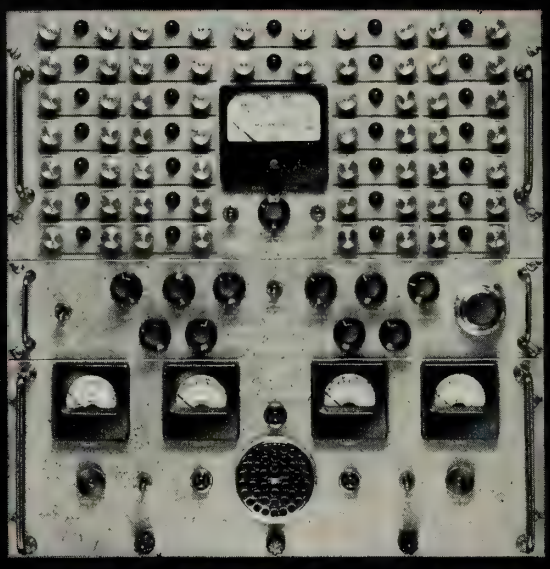
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The Arnoux Model TDS30-1 Decommutation System is compactly designed for use in airborne or trailer installed telemeter receiving stations and in portable check-out equipment.

- Miniaturization is the natural result of a new circuit design allowing the entire system to contain only 76 tubes as opposed to several hundred in competitive systems.
- Modular construction permits easy expansion of system to any desired channel capacity.
- Novel circuitry design does not reflect errors due to center frequency drift of sub-carrier oscillators, drift of discriminator D. C. output level, or tape playback speed errors.
- Built-in test selector permits visual inspection of waveforms throughout system for quick malfunction detection.
- Neon indicators on each gating unit give continuous visual indication of correct sequential operation.
- System accepts all standard IRIG inputs, either PAM or PDM, at any sampling rate from 75 to 900 per second.
- Overall linearity is within ± ½ % at maximum level. Long term level drift is within ± ½ %. Gain drift is negligible.
- Modular plug-in gating units allow quick replacement of faulty channels.
- Two spare units are maintained on standby for instant use.
- Power required is 115 volts, 60 cps, single phase. Optional 115 volt, 400 cps, power supply available for airborne application.

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Labor Eyes Missile Industry

by Donald E. Perry

Two AFL-CIO unions, representing the majority of organized workers in the missile and aircraft industries, are patting themselves on the back for a job well done in 1958 bargaining negotiations. Those negotiations are now nearly completed, although several long-range proposals got swept under the table in favor of immediate wage increas.

But, despite recession and large-scale industry layoffs, which made strikes or walkouts impractical, the "Big Two"—the International Association of Machinists (IAM), and the United Automobile, Aircraft and Agricultural Implement Workers (UAW)—take pride in their negotiated wage settlements.

Here's the reason:

Before contract talks, an estimated four-fifths of the more than 500,000 organized workers in missiles and aircraft had no cost-of-living clauses in their contracts. Two-year settlements made so far for these workers, range from 18 to 30 cents per hour, with an average of 21 cents. For the estimated one-fifth who had the cost-of-living clause, settlements were in the 2 to 11 cents per hour class, with an average of 6 cents per hour.

"This is a remarkable achievement," commented one union official, "in light of the recession, layoffs and stiff resistance to wage increase demands."

• **What's cost?**—What does this mean in cost to the industries?

There are no accurate figures, but simple arithmetic brings the cost-of-living increases alone to nearly $190 million annually. Add the fact that industry, with the exception of Republic Aviation, in 1959 will face a 3% increase with a minimum of 7 cents per hour. Republic next year will give a 10 cent raise across the board under new contract terms. Unions had sought a general 6% wage increase.

Major companies not having cost-of-living clauses before bargaining included Boeing (which has not settled but can be expected to follow the established trend), Convair, Lockheed, McDonnell, Republic, Solar, Rohr, Goodyear (Arizona) and Aerojet-General. United Aircraft settled late last year. Martin, which has the clause, is in negotiation and settlement probably will be made soon.

It's interesting that the industry had two strikes during negotiations, but neither apparently were for economic reasons. Seniority was the issue at the week-long Lockheed-Marietta and the 27-day Convair-Pomona strikes.

IAM and UAW, which this year put strong emphasis on coordinated bargaining, feel they also accomplished two other objectives: An additional holiday, which will be the day before Christmas; and correction in most new contracts, of so-called "wage plan abuses." Union demands were for elimination of multiple job classifications and establishment of job descriptions with clear-cut lines.

• **Heavier demands ahead**—Long-range proposals, of which one top union official said, "we couldn't fight too hard because this was the bread-and butter year," included severance and relocation pay, and per-diem. All, however, along with the formidable union demand for apprenticeship training, will be key issues in 1960 talks.

Bell Aircraft is the only company, according to UAW-IAM, which provides severance pay. Union objectives are one-half day's pay for each month of service on termination or layoff. Basically, the unions feel that a federal policy of channeling new contracts into so-called "distressed" areas would at least minimize effects of lay-offs in slack periods. Another objective is relocation pay.

The unions can be expected to put increased emphasis on negotiated relocation pay to enable their members to move with the plant at the company's expense with same or better working structure and the same basic working conditions.

The per-diem objective is to include provision for temporary transfers to other company locations. With missile hardware today in an accelerated testing state, more transfers can be expected. The unions contend the government has unjustifiably cut off per-diem allowances, and disagreement essentially is not with industry. Unions point out, however, that company policies have a wide-range of per-diem payments, and the government has indicated it would not cut per-diem benefits.

Still another union platform is for increased attention to on-the-job training. President A. J. Hayes of IAM, contends the old skilled journeymen "are dying off faster than young men are being trained to replace them."

Polaris Re-entry Cone To Be Designed by CTL

A contract for the design and development of re-entry bodies for Navy's *Polaris* IRBM has recently been awarded to Cincinnati Testing and Research Laboratories. The award, said to be initially for $500,000, was made by Lockheed Aircraft Corp.

CTL developed the material for the *Jupiter-C* test vehicle nose cone which was recovered May 18 in the Atlantic Ocean after firing from Cape Canaveral, Fla.

When the *Jupiter-C* nose cone was recovered, Elmer P. Warnken, president of CTL, said "the success of the *Jupiter* nose cone illustrates the critical re-entry problem of the IRBM has been solved."

Heat-Treatable Titanium Alloys Shown by Crucible

Crucible Steel Co., in a technical seminar at Pittsburgh attended by 40 industrial editors, announced the availability of three new heat-treatable titanium alloys.

One of these was disclosed as the first heat-treatable all-Beta titanium alloy to be produced, representing a major technological breakthrough for the titanium industry comparable to the development of austenitic stainless steel in the stainless steel field.

The three alloys have the unique advantage of being readily formed in the so-called "soft" condition and then strengthened by simple thermal aging treatments.

Ion Propulsion Contract Awarded Vitro Labs

Vitro Research Laboratories, Inc., has been awarded a contract by the Combustion Dynamics Branch of the Air Force Office of Scientific Research to investigate applications of the Sheer-Korman high intensity electric arc. This would apply to design data for two kinds of ion propulsion. Vitro's West Orange, N.J., facility will handle the work.

The Sheer-Korman arc is a Vitro proprietary development. It is a self-stabilized arc, generating ion densities on the order of four-to-five times those found in water-stabilized arcs. The ion flux, for example, is in the ampere region, rather than milliamperes.

Vitro will utilize electromagnetic principles in its ion-propulsion work, hoping to increase current accelerations of 1-to-3 electron volts up to 1000 e.v. Current Sheer-Korman plasma velocities, that do not employ nozzles or other special acceleration devices, range from 150 ft. per second in air at atmospheric pressure to 1200 f.p.s. at 1/1000th of an atmosphere. Magnetic acceleration of the charged ions should raise these figures by considerable amount.

AF Research To Determine Radar Effects on Personnel

The Air Force has an extensive research program under way to determine radar effects on personnel and to collect "information about suspected injuries or deaths resulting from radar exposure."

Although there has been no serious injury or death in the Air Force from exposure to radar, Col. George M. Knauf of Griffiss AFB, N.Y., in a speech to American Medical Association delegates, admitted that microwave injury "may produce harmful effects through some means other than simple heat."

Research on animals indicates microwave exposure produces changes in eyes similar to cataracts.

Col. John P. Stapp, U.S. Air Force Chief of the Aeromedical Lab at Wright Air Development Center, said there is little doubt of man's ability to survive space flight and return to earth.

He told the Military Medicine Section of the conference that volunteers have withstood three Gs for one hour in a transverse, semi-recumbent position at right angles to the line of force. "If this were a constant vertical acceleration at three Gs for one hour, final velocity would exceed 200,000 miles an hour, or eight times the speed required to escape the earth's gravitational field on the outbound space trip."

In an exclusive interview Stapp said, "We will have very good control of pullout forces in the North American X-15. A more sinister problem," he added, "is the decrease in blackout tolerance following 30 seconds or less of weightlessness. A 4.5-G pullout at the end of a zero gravity aircraft maneuver results in blackout of several times the duration experienced by the same subject after the same pullout, but not preceded by exposure to zero gravity."

Full-time Editor Assigned To ARPA-NASA Coverage

Two federal agencies which are important to the missile industry, as well as to the national welfare, are the Advanced Research Projects Agency and the proposed National Aeronautical and Space Agency. To give its readers up-to-date news coverage of these two agencies, MISSILES and ROCKETS Magazine recently assigned a full-time editorial staff member to cover activities of ARPA-NASA.

The editor assigned is Donald E. Perry, a member of m/r's staff for the past several months. Mr. Perry joined m/r after service with the Martin Co., and brings to the magazine total newspaper experience of more than 12 years, including a stint as aviation editor.

Congressman Attacks Snyder 'Censorship'

Spokesmen for the Department of Defense and the Administration have repeatedly cited a number of reasons for integration of the information services. These included objectives no one could argue with—such as elimination of duplication, greater efficiency, and speed-up in the flow of information. Interlarded are other terms—"timeliness", "public understanding", and most important of all, "policy".

"The objective in the public affairs area is to obtain unified policy direction, and not centralized operation."

Deputy Secretary of Defense Donald A. Quarles, said the above statement at closed sessions recently held at Quantico. These were the sessions at which Navy's CNO Arleigh Burke was reportedly brought into line.

Rep. John E. Moss made this comment in regard to Quarles stated objective:

"From Mr. Murray Snyder's first appearance on the scene, I have become increasingly convinced it is his job to create a spokesman on all matters of defense. Any policy as far-reaching as the one proposed was not conceived by accident. It is the most complete Pentagon censorship ever employed, including times of war.

" 'Timeliness', 'security', and 'policy' would be words to be defined by Mr. Snyder. He would be maker of the laws, judge of the courts, and hand down decisions from which there would be no appeal. His policy would be nothing less than an atmosphere of expediency determined from day to day, in accordance with the wishes of his superiors," Moss concluded.



Wide-World Photo

Murray Snyder

Subroc Systems Contract Goes to Goodyear Aircraft

Prime systems responsibility for developing the underwater-to-air-to-underwater *Subroc* weapon has been awarded to Goodyear Aircraft Corp., in a $65-million contract awarded by the Navy Bureau of Ordnance.

Subroc combines ballistic rocket and torpedo capabilities in what will initially be an anti-submarine weapon. However, Navy considers this concept to be susceptible to considerable development, and contemplates that it will ultimately incorporate anti-aircraft/missile and anti-surface target capabilities. A primary advantage of *Subroc* is that it will utilize existing submarines as launching sites.

Principle subcontractors on *Subroc* are the Kearfott Co., Clifton, N.J., and Librascope, Glendale, Calif., who presumably will share responsibility for development of guidance.

Goodyear has named R. L. Burtner as *Subroc* systems manager; assisted by A. E. Bjerke, assistant project engineer; J. R. Stair, customer relations; W. H. Wood, manufacturing; W. F. VanBuskirk, master planning; J. S. Young, purchasing; G. E. Marquis, quality control.

Goodyear will work closely with the Naval Ordnance Laboratory, White Oak, Silver Spring, Md., which has been carrying out preliminary investigation and development.

New X-15 Inertial System Developed by Sperry

An advanced flight instrument system, which will provide the pilot of the hypersonic X-15 with inertial flight aids and sensing devices on outer space trips, has been developed by Sperry Gyroscope Co.

The new system will help control the rocket research plane to keep it from burning if it reenters the denser atmosphere too steeply.

The instrument system, which has been under development for about a year, will have its preliminary test this summer by the National Advisory Committee for Aeronautics. A McDonnell F-101 Voodoo fighter will be used as the flying rest bed. The X-15 is expected to fly at about 3,600 mph at over 100 miles altitude.

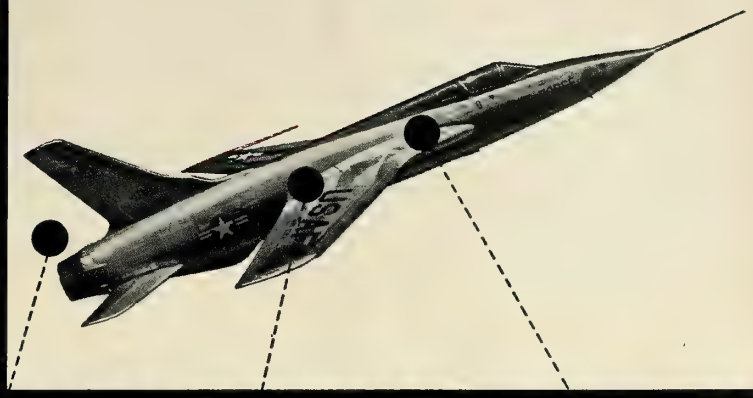
The new system is composed of a three-gyro stable platform which provides critical attitude, velocity, distance and altitude sensing and a lightweight computer to interpret data. Developed to withstand accelerations more than ten times the force of gravity, it cannot be jammed during operations.

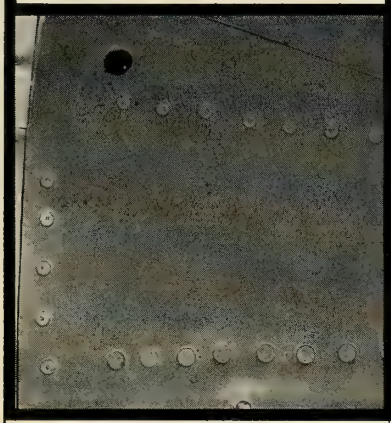
The NACA pointed out that the system may be adaptable to other missile guidance and space experiments.

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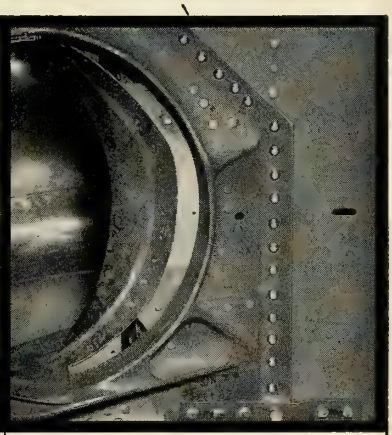




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Desert Bristles With US Missiles

WHITE SANDS, NEW MEXICO—Army missile men have made a major breakthrough in Public Relations. And it should be noted that this was accomplished without any recourse to public relations personnel from ABMA.

They achieved the break with the most impressive missile show in the world to-date, last week's two-day missile firings in the hot New Mexico desert. The show, at the McGregor Missile Range near Fort Bliss, Tex., turned out 63 Army and Air Force generals, 4 Navy admirals, 13 NATO generals and admirals, 18 other Allied officers, 100 industry leaders and 120 newsmen and photographers.

The perfectly organized program was put on by the Army with the cooperation of the missile industry. The Army's Deputy Chief of Public Relations, Brig. Gen. "Ted" Clifton, fostered the idea almost a year ago.

The two-day field session was tagged AMMO—Army Mobile Missile Orientation. Scores of missiles, ranging from helicopter-mounted 2.75 in. rockets to the big *Corporal* missile were fired at White Sands, McGregor and Hueco ranges in the western Texas and southern New Mexico deserts. AMMO was planned as a demonstration of the Army's present missile capability both offensive and defensive.

• **Brass attends**—Secretary of the Army Wilbur M. Brucker topped the Army team which included Assistant Secretaries Dewey Short, George H. Roderick, and Hugh M. Milton II. General Nathan Twining, Chairman of the Joint Chiefs of Staff was the ranking military observer. Other top men in uniform included General Maxwell D. Taylor, Army Chief of Staff; Lt. Gen. C. E. Hart, Commanding General of the Army Air Defense Command; Maj. Gen. J. H. Hinrichs, Chief of Ordnance; Maj. Gen. J. B. Medaris, Commanding General, of Army Ordnance Missile Command, and Maj. Gen. Sam C. Russell, Commander of the Army Air Defense School at Fort Bliss.

Missile industry firms represented included Bell Telephone Company, Thiokol, Chrysler, Douglas Aircraft, Firestone, Curtiss Wright, U.S. Steel, Gilfillan Bros., Raytheon, Pratt & Whitney, Sperry Rand and the Martin Co. Also, Callery Chemicals, Western Electric, Radioplane Division of Northrop Aircraft, Bendix Aviation, American Machine & Foundry and Sikorsky Aircraft.

Army planners said the orientation was also designed to show industry observers fire power, and missile mobility. The Army feels, spokesmen said, that industry lead time is too long in today's fast-moving missile age. Industry spokesmen questioned this point. The Army should be more specific in outlining missile needs, they said.

• **The show**—Demonstrations included *Honest John* firings after a *Chopper John* concept mission *(Honest John* airlifted to launching site, with launcher, by helicopter); *Nike Ajax* firing and direct hit on an airborne Air Force bomber; the *Corporal* impacted 48 feet left and 12 feet short of the target, which was 31 miles from the launching pad.; and a *Talos* firing.

Briefings were given on *Bredstone* and *Sergeant* missile systems, and on *Nike-Hercules, Hawk Dart, Little John* and *LaCrosse.*

Most impressive and possibly the most promising of the missile demonstrations was the showing of how the Army is marrying the rocket to the helicopter.

In May, 1956, the Commanding General, U.S. Continental Army Command authorized the Army Aviation School to conduct certain experiments to determine the feasibility of adapting existing weapons, including missiles, to helicopters. In early '57, the feasibility was established, and the Army now is inviting industry to submit ideas and proposals for an up-to-date helicopter-missile system.

In the free world, the French have held a leading position in this field, with their installation of the SS-11 *(Dart*-type) missile on the Alouette helicopter.

Atlas Will Boost Final Animal Carrying Capsules

Atlas boosters will be made available for launching of recoverable animal-carrying satellites in the early Spring, m/r has learned. Early tests, however, on recoverable satellites probably will be using the *Thor.*

Availability of an *Atlas* booster raises the premise that Convair will be sufficiently along in production of the ICBM to release it for biological experiments.

First passengers will be mice (a *Thor* has already carried one), and the *Atlas* booster probably will contain a well-trained chimpanzee. Reports indicate that the *Atlas* boosted satellite will make only one revolution of the earth before it reenters.

AVCO Research Laboratories, in conjunction with Convair, Aeroneutronic Systems, Lockheed, Boeing, Douglas, Republic, Northrop and Goodyear have put in bids.

industry news countdown

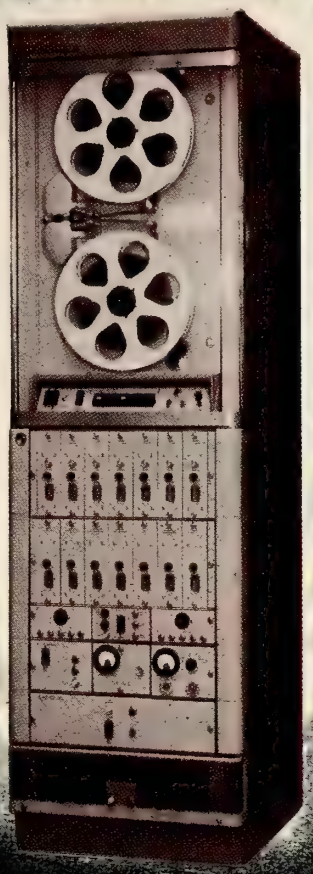
• **About missile spending:** The balance is tipping heavily towards missiles at the expense of aircraft. Official Pentagon figures: Aircraft dropped from $8 billion in Fiscal Year 1957 to $7 billion in 1958. Cash outlays for missiles in 1958 are pegged at $2.955 billion, compared to $2.09 billion in 1957 and $3.44 billion forecast for 1959. Of the lot, AF will spend $2.166 billion in 1959; Army, $791 million; Navy, over $487 million. These figures do not include electronics, ground handling, R&D, industrial facilities. Actual total's near double.

• **For a take-out on patents,** Trademarks and Copyrights in space age R&D, get a copy of the Senate Judiciary Subcommittee report on P., T. & C. on "the impact of the patent system on research", which concludes that the patent system has contributed little to the progress of science.

• **Defense Secretary McElroy has ordered** establishment of a Supply Support Center to monitor and coordinate the procurement of both "commercial" and "non-commercial" materiel common to all three services. To be operative by September-end, it will not do any actual buying. . . . **More red tape:** Defense Department Directive No. 4000.4 (June 10) concerning conservation of critical materials will shortly result in promulgating directives to the missile contractor—**Less red tape, maybe:** Defense Department has killed off 133 joint military service committees and given 94 others until August 1 to justify their existence. Some of those eliminated were concerned with such things as communications-electronics, logistics plans, aluminum forgings, close-tolerance bolts, extrusions.

• **Around Capitol Hill:** It looks like Renegotiation Act extension will be delayed beyond present expiration date of December 31, 1958. House Ways and Means Committee wants more time to study proposed changes. Lapse won't mean a period free of renegotiation, however, since renewal will be retroactive . . . **The House-passed H.R. 8002,** designed to return Government to an accrued expenditures accounting system, has been sent to Senate Appropriations Committee, with report required back in 15 days. Hearings are planned. Passage of this bill would help preclude the kind of spending limitations that were imposed last fall . . . **House Armed Services Investigation Subcommittee** starts hearings today on

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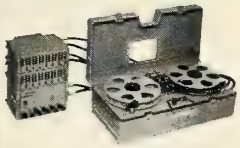
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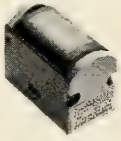
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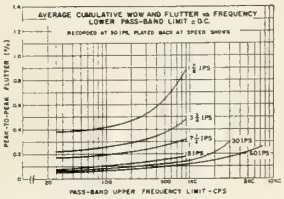
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OFFICES IN PRINCIPAL CITIES THROUGHOUT THE WORLD

. . . industry news countdown

Armed Services Procurement Regulations in an effort to cut Defense Department's overhead and simplify procurement rules . . . **Raytheon Mfg. Co. has asked Congress** to omit "patent rights section" from pending National Aeronautics and Space Agency bill, in order to give the agency some discretion as to who would own patent rights resulting from private or publicly-financed space age R&D . . . **Defense Production Act** has been extended for another two years. This is the law that provides for stockpiling of essential raw materials, granting of priorities, loan guarantees for government contractors.

• **Advanced Research Projects Agency has been ordered** by Defense Department to get busy with a solid propellants research program designed to give "specific impulses at least 10- to- 20% higher than other propellants now under development for operational applications" . . . First *Titan* ICBM will soon arrive at Cape Canaveral for testing . . . **Brig. Gen. Homer A. Boushey forecasts manned outposts** on both Moon and Mars with 20 years; sees overwhelming urgency for military exploration of space. He spoke at a recent Rocket Fuel Chemists Meeting in L.A. . . . **ARPA has ordered** immediate establishment of a radar and communications fence across the southern U.S. to detect and track all satellites up to 1,000 miles . . . **AMC has created** an Electronic Support Subsystems division . . . **Navy's stepping up firing of *Polaris* test vehicles at Cape Canaveral . . . Defense Department missile czar** W. M. Holaday indicated (at IRE meeting) that free-fall nuclear bombs soon will be entirely replaced by *Rascal, Corvus, Hound Dog* and others in the works . . . **Holaday also named** BuOrd senior systems engineer E. E. Harriman as his chief scientific advisor . . . **AF Deputy Chief of Staff (Materiel) Lt. Gen. C. S. Irvine** told an Industry Missile and Space Age Conference in Detroit that contracts will be placed more and more on the basis of performance, rather than prestige.

• **Secretary McElroy says Fiscal Year 1960 budget** will go "somewhat" above 1959's $41 billion level; also says he expects a decision between *Thor* and *Jupiter* as the IRBM by year end . . . **GE Board Chairman P. D. Reed** has asked that allowable Defense business profit margins be related to contract performance; agrees with some top-level Pentagon thinking . . . **Dr. P. D. Foote, Assistant Defense Secretary** for Research and Engineering, says that too little is being done to support basic research; that this effort will increase in the next and succeeding years . . . **Army Secretary W. M. Brucker** says of 38 *Jupiters* launched, 29 were completely successful; seven partially successful; and that two were of no scientific value at all, even though all 38 cleared launching pad.

• **Nation's first operational SAGE installation** (McGuire AFB) cost $137 million . . . **Lockheed Aircraft Corp.'s Missile Systems Div.** is splitting R&D into three stages—advanced systems, spacecraft and missiles, communications and controls . . . **Litton Industries, Inc.** has signed an agreement to purchase **Airtron, Inc. . . . Thompson Products' Tapco Products** has created a new sales and marketing organization for missiles, aircraft, electronics, nucleonics . . . **Ramo-Wooldridge's STL Aeronautics Laboratory** has been redesignated as **Astro-vehicles Laboratory . . . Aeronutronics Systems, Inc.** has started work on a computer development building at Newport Beach, Calif. . . . **Sylvania Electronic Systems Div.** has announced plans for construction of a 70,000 sq. ft. computer plant at Williamsport, Pa.

• **Haller, Raymond and Brown** (recently acquired **Singer Sewing Machine Subsidiary)** has opened its new permanent headquarters at State College, Pa.—HRB specializes in R&D on infrared, radar, fire control, surveillance systems . . . **Hef, Inc.,** is building a multi-million-pound-per-year ammonium perchlorate production plant near Columbus, Miss. . . . **Mithra Engineering Co.** has been formed to work in experimental testing field . . . **Solartron, Inc.,** has been named exclusive U.S. sales representative for **Ericsson Telephones Ltd.** and **Goodmans Industries Ltd.**

• **American Electro Metal Div.** of **Firth Sterling, Inc.,** has released a price list of over 60 borides, carbides, nitrides, silicides and inter-metallic compounds . . . **Kaiser Aluminum & Chemical Sales, Inc.,** announces availability of high purity, high tensile strength aluminum casting alloy, X357.

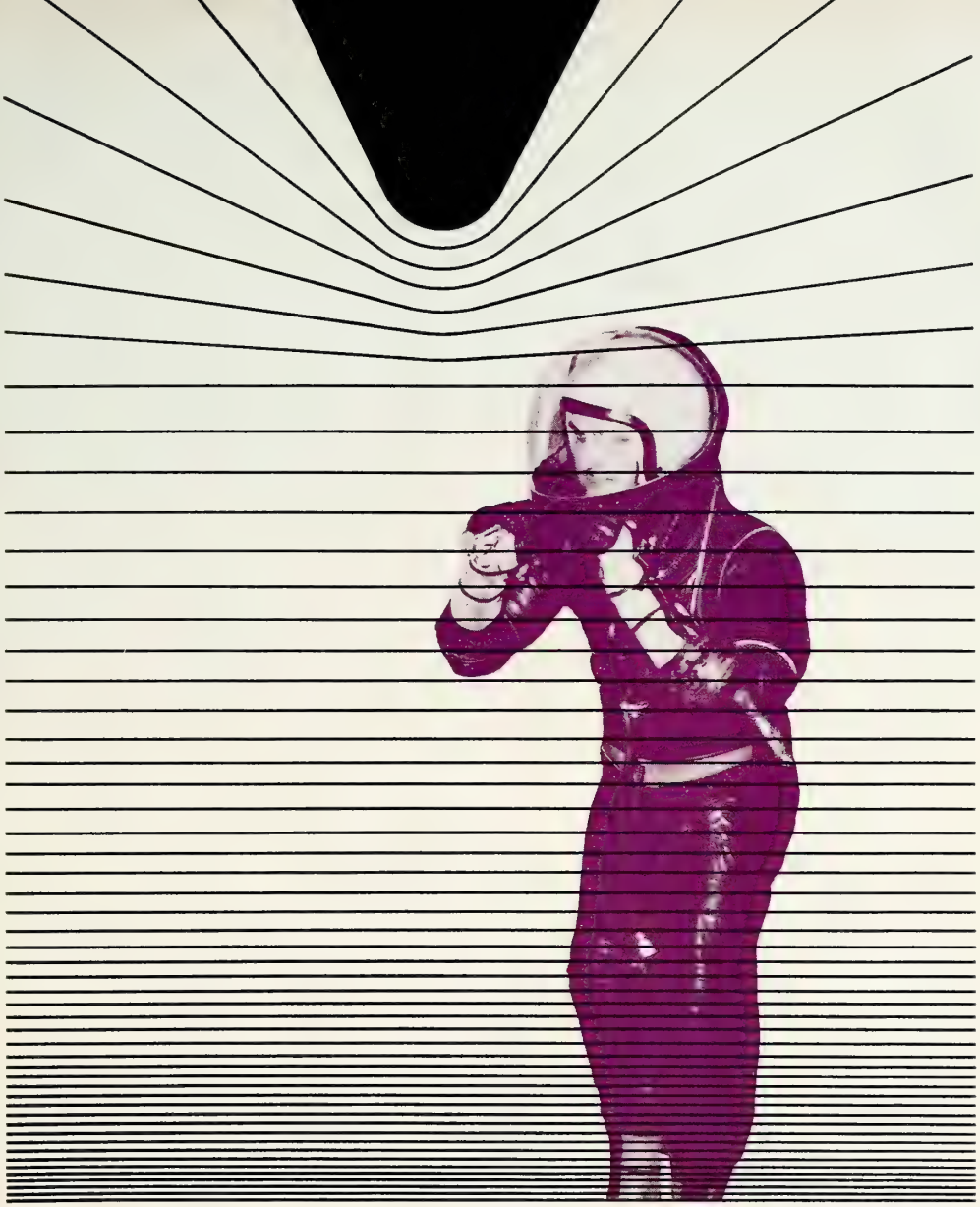
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advertiser's index

Aerojet-General Corp., Sub. General Tire & Rubber Co. ... 6
American Bosch Arma Corp. 24
Arnoux Corp. 32
Avco Mfg. Co. 39
Clifton Precision Products Co., Inc. ... 40
Consolidated Electrodynamics Corp. ... 37
Diversey Engineering Co. 4
Douglas Aircraft Co., Inc. 16
Dow Chemical Co., The 15
Food Machinery & Chemical Corp. ... 31
Hi-Shear Rivet Tool Co., The 35
Hydro-Aire, Inc. 2
Janitrol Aircraft Div., Surface Combustion Corp. 30
Walter Kidde & Co., Inc., Aviation Div. 27
North American Aviation, Inc., Missile Development Div. 12
Ryan Aeronautical Co. 8
Solar Aircraft Co. 28
Thompson Products, Inc. 19, 20, 21, 22
Titanium Metals Corp. of America 17
Transue & Williams Steel Forging Corp. 3



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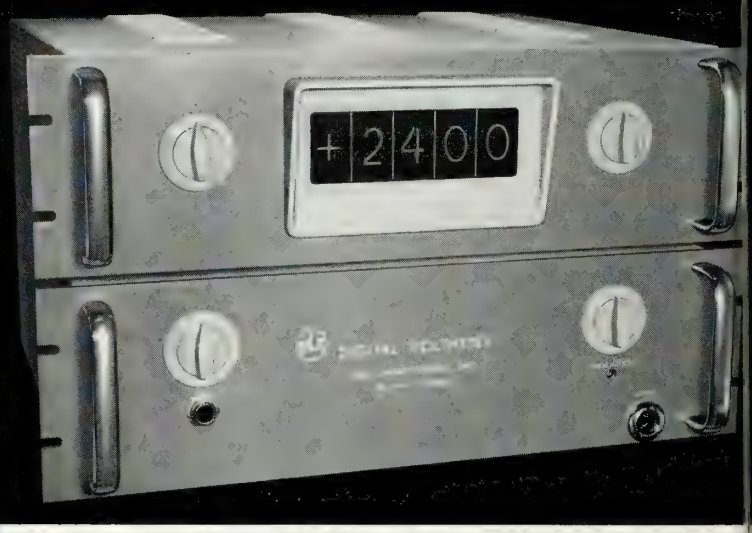
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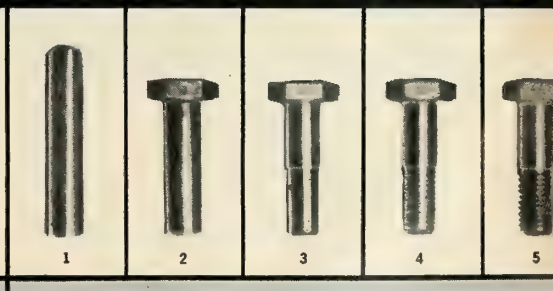
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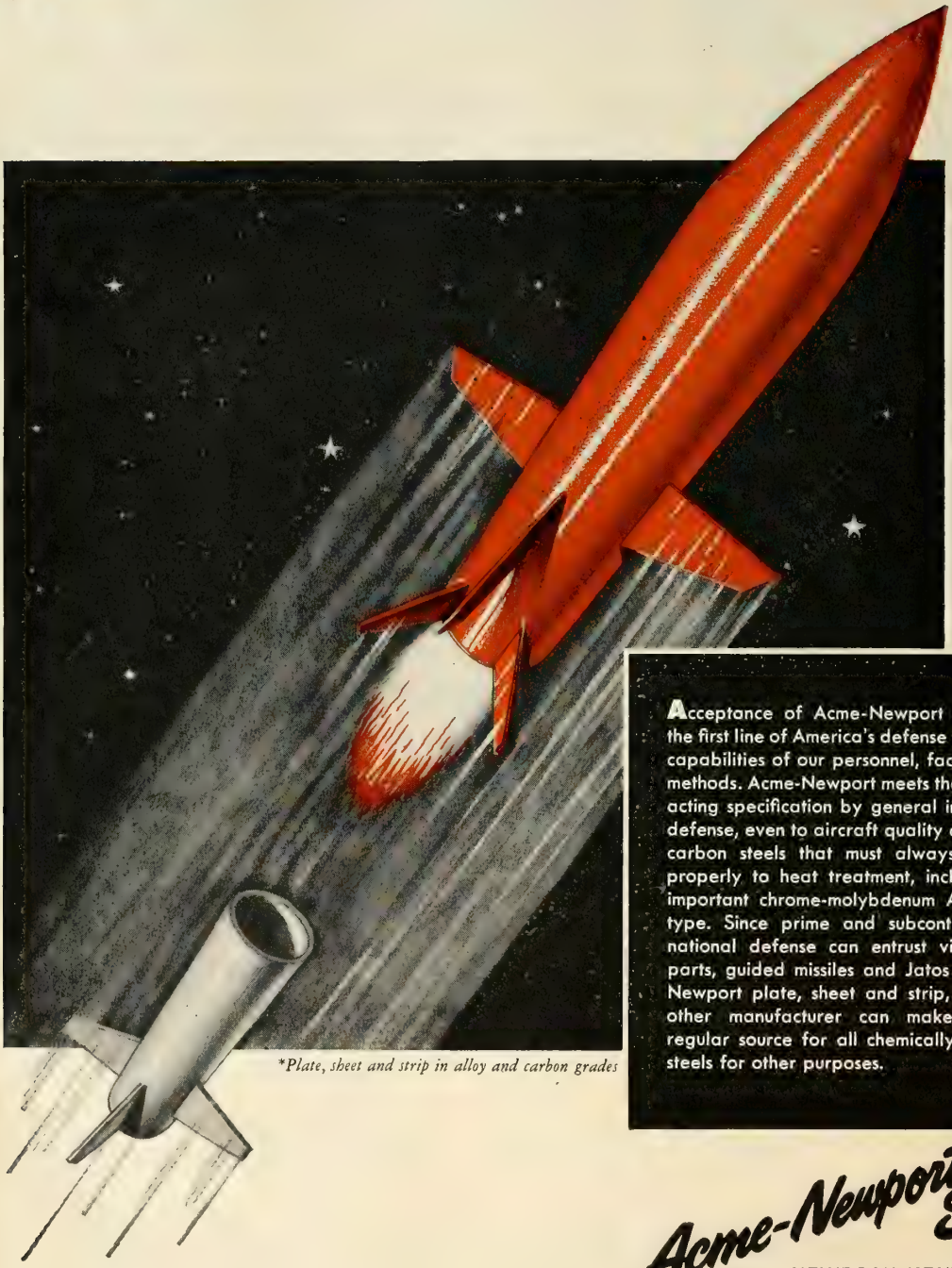
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Contents

news

Balanced Missile Fleet is Navy Aim
by William O. Miller 11

ARPA Puts Damper on Roles & Missions Battle 13

Urge Reorganization of ARDC 14

Operation *Gaslight* Yields Anti-Missile Data 14

What's the Law in Outer Space? 16

features

Optical Checks Reduce Tooling Costs
by Peer Fossen 19

Neon "Sign" May Map Radiation Belt
by Savo Coric 22

A Cold Problem In A Hot Business 24

Glass-ceramics—New Vista for Radomes
by Norman L. Baker 27

High Energy Liquid Fuels Promising
by Donald E. Perry 31

columns

Missile Week 9

Space Age 34

West Coast Industry 39

Missile Business 51

Astrionics 55

departments

Editorial 7

When and Where 35

New Missile Products 40

Letters 42

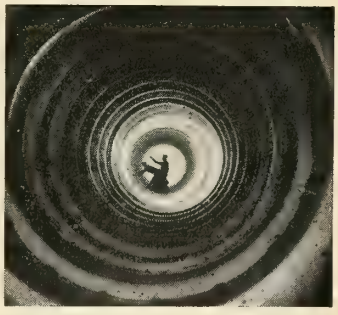
Book Reviews 46

Industry Report 51

Missile Miscellany 56

Missile Electronics News 57

Industry Countdown 62



cover

Not another tube for the Hudson River, but the outer shell and inner reinforcement rings of liquid oxygen loading tanks for Douglas Aircraft's Thor IRBM missile system. Here, inspectors at Cambridge Corp's. Lowell, Mass., plant check the fit-up of rings and outer aluminum skin. (See story on page 24.) Cover photo by Seabrook Hull.

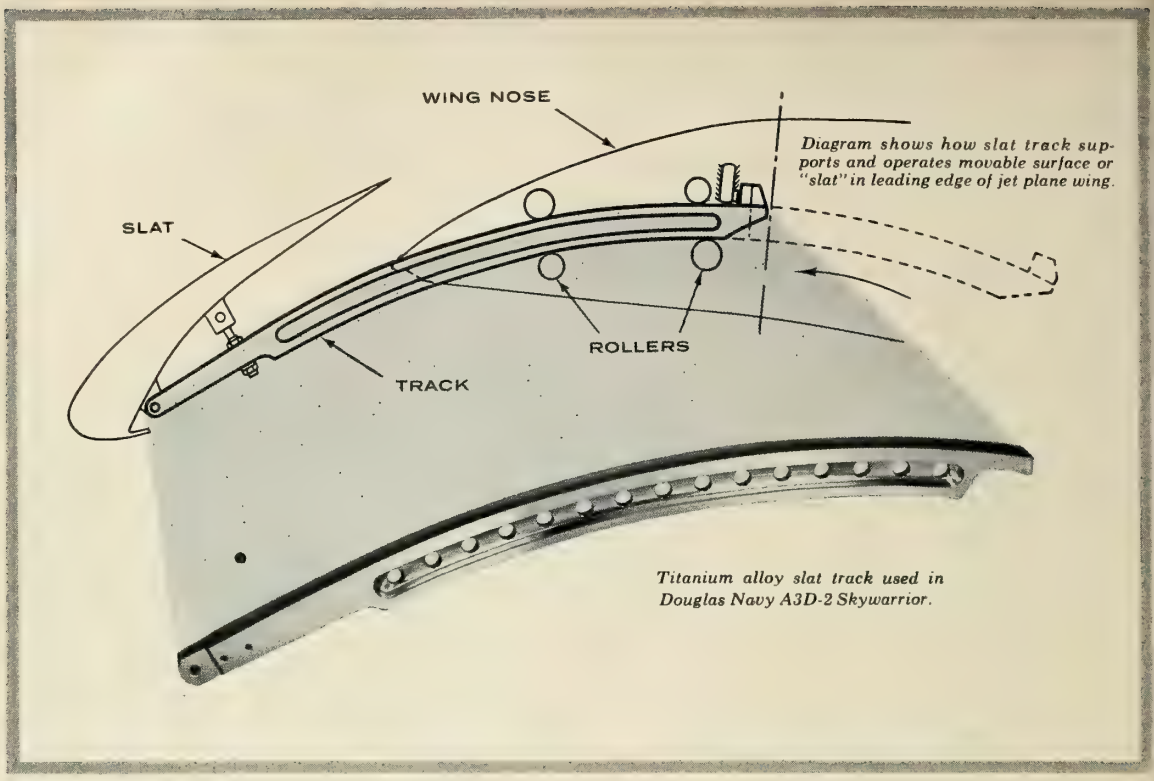


Diagram shows how slat track supports and operates movable surface or "slat" in leading edge of jet plane wing.

Titanium alloy slat track used in Douglas Navy A3D-2 Skywarrior.

How Douglas Aircraft used Titanium to gain

44% WEIGHT SAVING...IMPROVED PERFORMANCE

Douglas engineers faced numerous problems in designing the Douglas A3D-2 Skywarrior slat tracks. Among these were problems of weight reduction, high inertia forces, corrosion and compass deflection.

The application called for a metal with high strength-to-weight ratio, superior corrosion resistance, and non-magnetic properties. Engineering evaluation pointed to heat-treated 6Al-4V titanium alloy as being most suitable for this application.

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3. *Titanium's non-magnetic properties minimize compass deviation.*
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DESIGN REQUIREMENTS AND PROPERTIES OF 6Al-4V TITANIUM

Property	Douglas Min Design Requirements	Average Test Results (formed and heat treated)
Ultimate Strength, psi	150,000	150-159,000
Yield Strength (0.2% Offset), psi	135,000	136-146,000
Elongation (in 4D), %	8	13
Reduction of Area, %	20	40-43
Rockwell C Hardness (max)	42	—

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ARPA – The Great Experiment

Basic research, for more years than we like to recall, has been the whipping boy of the nation's defense budget. Year after year, less than one percent of U.S. defense money has gone for basic research. Almost all activities in this forward area were predicated on the so-called necessity of tying research to a specific military objective.

Practically nothing was done to look ten, fifteen, or twenty years into the future in problem areas to see what could be attained in the way of perfecting a better weapon system than the current year's model—or in preparing a defense against an enemy weapon realized through some technological breakthrough.

Rocket engines are just one of many examples that come to mind. Our military objectives precluded development of chemical boosters of 500,000 pounds thrust or more. While we waited, Russia acted in research and development. *Sputniks* I, II, and III are the results.

We have concentrated, quite thoroughly, in spending billions for production of missiles and aircraft, which, by the time they become operational, were obsolete. Early decisions in the research and development phase could have prevented costly production of many weapons which perform similar missions.

Another example: in the early development years of ICBMs and IRBMs, little money support was given to what should have been a paramount research objective: namely, basic work into missile flight phenomena which would bring us closer to an effective defense against the ICBM. We still lack the defense today—and must wait and wonder.

Five months ago, the Defense department—under Presidential pressure—made a decision which, although we think it may be a little too late, is a good one. The Advanced Research Projects Agency was organized and told to manage defense research, eliminate costly duplication of weapon systems, and to assign research to the military departments according to capabilities, rather than roles and missions.

For the first time, research, under ARPA, is getting a healthy shot in the arm. For fiscal year 1959, $520 million is programmed for ICBM defense, military reconnaissance satellites and space technology (see p. 14 of this issue).

Some of the organizations that are already working under ARPA have compared the direction to that of a board of directors—able to weigh individual requests in the broad sense which the U.S. missile and space effort has required for so long. A "board of directors" able to consider everything proposed to it in a dispassionate sense—and with the authority to choose the best approach for any given project—is almost without precedent in our military establishment; more so when the "board" is run primarily by civilians.

Many times in the past, committees have been formed and staffed by competent men, given definite missions, a definite budget, and a definite time limit.

But over and over again, these groups have made studies and the results were never brought to light because the sponsor of the study didn't agree with the results. Sometimes, results have been buried because members of the committee had no real identification with the objective. We can never hope to achieve goals when committee members are operating on the basis of "look in once a week and say yes or no." This, fortunately, is not the way that ARPA is set up to operate and, apparently, is not the way it is operating. We can be thankful for this.

Under the leadership of such dedicated men as ARPA director Roy Johnson, deputy director Rear Admiral John E. Clark, and chief scientist Herbert York, ARPA is fast emerging as the one Defense department agency that is not interested in empire building, but in bringing a forward look to Pentagon management. ARPA's methods of operation could well be duplicated by other defense organizations.

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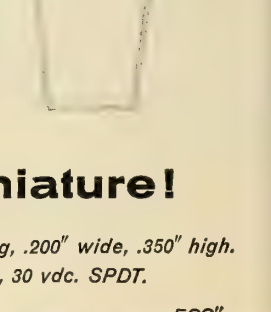
This new "SX" basic switch represents an entirely new set of answers to the space-weight problems in dependable precision switching. It combines new small size with more than ample capacity for wide usefulness, meeting the pressing demand for miniaturization combined with reliability.

In its exacting development, many problems of design, testing and quality control presented themselves. However, 23 years of experience proved of immense value. As a result, a new standard has thus been set by which all precision switches must be measured.

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An m/r staff report from WASHINGTON

• **SECRETARY OF THE ARMY BRUCKER** took a step this week to ward off any catastrophic publicity, such as resulted when *Vanguard* fizzled, when he issued a statement hedging on an Army try to launch a lunar probe before the end of July, as reported in last week's m/r. He said the report has no basis in fact. However, in the same statement he urged defense agencies to "proceed speedily, and without fanfare" toward further achievement in space exploration.

• **THE NAVY MOVED AHEAD** in replacing guns with missiles with the award of a $10.3 contract to the Sperry Gyroscope division of Sperry-Rand for the direction equipment for *Talos*. Now operational on the cruiser Galveston, *Talos* will make up the main battery of the cruisers Little Rock, Oklahoma City and Albany, and the first nuclear-powered surface ship, the cruiser Long Beach. (see also p. 11)

• **THE PRESIDENT'S REORGANIZATION PLAN** got a pat on the back from Army's Chief of Staff, Gen. Maxwell Taylor when he appeared before the Senate Armed Services Committee. The General, however, steered clear of the controversial 200-mile limit for Army missiles saying it would fall in the "twilight zone" of combatant functions as defined by the Key West Agreement, and wouldn't opine how reorganization might affect it.

• **BACKING UP HIS CHIEF**—Brigadier General A. W. Betts, of the Office of the Director of Guided Missiles, in an address before the National Federation of Business and Professional Women's Clubs in Seattle, Washington, backed up Gen. Taylor. He said that there are two aerodynamic missile systems now operational, the *Regulus* and the *Matador,* with essentially the same range, accuracy and warhead capabilities. Betts pointed out that a Defense organization of the nature proposed by the President would have prevented this unnecessary duplication. For the same amount of dollars invested in the two programs, we could have had a 25% greater military capability with a single missile.

• **LEGISLATORS UNHAPPY WITH *POLARIS* PROPELLANT CONTRACT.** The House Armed Services Investigation Subcommittee will look into at least five cases of multi-million-dollar contracts being let to private industry for procurement, which could be filled by government-owned facilities. Maryland legislators, miffed because of a $10 million facilities contract to Aerojet General for *Polaris* propellant grains, while the Indian Head (Md.) powder factory was laying off 2,000 workers, have prodded Rep. F. Edward Herbert's subcommittee into asking Navy officials to explain. Herbert says the Indian Head situation will be studied as a representative case.

• **WASHINGTON TALK THIS WEEK** concerns several developments in the Thompson Products, Inc. area. First, Space Technology Laboratories was established as a wholly-owned subsidiary corporation; then Thompson Products announced the formation of the TAPCO group, comprising five divisions of the Thompson organization; and then the final statement—that Thompson and Ramo Wooldridge would combine to form a new organization called Thompson Ramo-Wooldridge. It is reported that T-RW is being considered as prime contractor for *Minuteman.*

• **AIR FORCE BUDGET** request for FY 1959 includes delivery of about 15 C-133 transports—and AF wants about 50 of these big planes. They are the only transports that can carry *Atlas* ICBM's intact.



The engineers got a close-up view...

but this AUTO ZOOM Lens took the risk*

The bird was a bust. But the engineers, using closed-circuit TV and the Perkin-Elmer AUTO ZOOM Lens pictured above, got a pad-side view. Lens and camera (and the bird) were the only casualties . . . a small price to pay for observations that will help insure the success of the next launching.

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JULY 14, 1958
VOL. 4, NO. 2

missiles and rockets
MAGAZINE OF WORLD ASTRONAUTICS

Balanced Program Places Navy First

Congress Told That Cutbacks in Ship Construction Will Be Offset by Missile Power of Vessels Approved

by William O. Miller

Navy scientists, hardware experts and strategists are quietly working to put the Navy in the world's number one spot insofar as missiles are concerned, if indeed, it does not already hold that place. There is no lack of confidence, even if there is what Navy men consider a shortage of funds—less than half the dollars allotted the Air Force for missiles.

The Navy alone has had at least one guided missile in each category—surface-to-surface, surface-to-air, air-to-surface, and air-to-air—in production for Fleet use for several years. Second generations of these missiles, all with improved capabilities, are almost ready for deployment.

Citing an old ordnance adage, "the longer the range, the greater the error," one Navy spokesman said:

"The ICBM is for the birds. We'll have the equivalent of an ICBM in *Polaris*, with distinct advantages an ICBM does not have:—(1) mobility of launching site, (2) greater accuracy, (3) solid propellant, and (4) the secret hiding places the vast ocean depths afford."

Recent cutback in funds for guided missile ships in no way indicates a downgrading of their importance—or a waning of interest—in the Navy's surface-to-air or surface-to-surface birds.

That's clear enough after a close check in Washington. The reason for the cutback—and it is to the tune of more than $490 million—is the fact that the Navy had to do something to balance rising costs against budgetary limitations.

Result: nine ships were listed by the Secretary of the Navy for elimination from the current program. Six of these were guided missile vessels—four frigates and two heavy cruisers—which would have carried the *Terrier* and *Talos* missiles.

Of course, there's more than cost increase in shipbuilding involved, Navy planners readily admit. Much of the increased cost results from innovations and new-model equipment that is asked over the four-year lead time normally required for construction.

• **Hope for replacement**—Testimony before the House subcommittee on appropriations pointed out the Navy's thinking on how to make cuts without losing effective power.

Rear Admiral J. E. Clark, until recently head of CNO's Guided Missiles Division, said:

"The Navy is now developing three missiles, in three sizes, for three types of ships. For destroyers, the *Tartar*; for destroyer leaders and frigates, *Terrier*; for cruisers, *Talos*. Objective of a 10-year program is improvement of these missiles, so that *Tartar* will eventually yield the performance of *Terrier*, and *Terrier* will equal *Talos*."

Overall, the Navy included in its budget requests funds for only 11 missiles. They eliminated two (*Sparrow* I and *Petrel*), and cut funds for another (*Regulus I*) to just $1.5 million, to cover field service to the missiles already in hand.

In addition to the 11 operational missiles—including two air-to-air birds—the Admiral testified that several others are in the research and development stage, giving the Navy a present stable of about 14 missiles.

Inasmuch as improvement of the present missiles is the crux of the Navy's program, according to Adm. Clark, research and development must continue improving reliability, extending ranges and increasing resistance to countermeasures. Twelve missiles have been eliminated from the Navy's program in line with this reasoning in the past eight years.

A number of factors went into picking the six guided missile ships that were cut from the program. Most important, contracts had not been signed for new construction of the destroyers or the conversions of the cruisers. Consequently, the expense of contract termination on other vessels was eliminated. Other factors included location of the yards doing the work, and work already underway on similar types.

The cruisers eliminated—the "Chicago" and "Fall River"—may be put back in the next year's budget. In any case, follow-on types in succeeding years might provide the balanced fleet the Navy says it needs to fulfill its role.

The contract price of $14 million for the conversion of the "Little Rock" is subject to redetermination when the work is 70% complete. The $14 million contract for the conversion of the "Oklahoma City," and the $13 million figure for the work on the "Springfield" is subject to adjustment when 30% completed.

• **Construction work**—The only new construction work in the guided missile cruiser program is the "Long Beach," the Navy's first nuclear-powered surface ship. This will be the Navy's first ship to mount three missiles—*Terrier*, *Talos* and *Regulus* II.

Complete contract figures are not available, but Westinghouse has an $18-million contract for the reactor com-

Electronics Spending Tops 1957 Totals

Defense electronics procurement during the first nine months of FY 1958 had reached a total of $2.863 billion, vs. $2.451 in FY 1957, according to figures released by the Electronics Industries Association.

Current estimates are that spending for the entire year will be substantially over the $3.5 billion recorded last year and may reach $3.9 billion, the largest sum ever spent for electronics by the military in a single year.

The EIA computation, intended primarily to be used to depict trends, and subject to later revision, shows the following electronic figures (in millions) for the first nine months of FY 1958, ending March 31:

Budget Category	1st Quarter	2nd Quarter	3rd Quarter	FY 1958 to date:
Aircraft	$340	$346.0	$359.0	$1,045.0
Ships-Harbor Craft	23	25.0	24.0	72.0
Combat Vehicles	1	—.2	—.1	.7
Support Vehicles	1	.7	.6	2.3
Missiles	273	299.0	319.0	891.0
Elec. & Comm. .	204	214.0	183.0	601.0
Research & Dev.	73	74.0	75.0	222.0
Miscellaneous ..	11	9.0	9.0	29.0
Total (FY 1958)	$926	$967.5	$969.5	$2,863.0
Total (FY 1957)	$637	$876.0	$938.0	$2,451.0

partment components alone. General Electric has the $4-million job of building the main propulsion turbines and gears. Bethlehem Steel received a letter contract for $2.5 million for preparation of working plans.

The "Albany," the only one of three heavy cruisers selected for conversion from the active fleet, will be the first of the "double-ended" conversions. It has *Talos* fore and aft, and *Tartar* for the anti-aircraft battery.

Partial conversions have been completed on four other cruisers, giving them a limited guided missile launching capability. They are the "Los Angeles," "Macon," "Toledo" and "Helena."

Although the four frigates (DLG) were eliminated by the June cutback, six guided missile frigates and one nuclear-powered guided missile frigate have been requested in fiscal 1959.

An $11.9 million contract has been awarded to General Electric for the design and furnishing of a long-lead-time reactor compartment component for the nuclear powered frigate (DLGN).

The contract price for the first three of the DLG's, to be built by Bethlehem Steel, Quincy, totals $52.4 million. The Bath Iron Works $40.5 million contract covers the last two in DLG's in the current construction.

Name	Desig.	Building Yard	Date Complete	Cost	Fiscal Year Authorized	Missiles
Cruisers						
Boston	CAG 1	(active)	---	---	1952	Terrier
Canberra	CAG 2	(active)	---	---	1952	Terrier
Galveston	CLG 3	(active) commissioned 5/58	---	---	1956	Talos
Little Rock	CLG 4	NY Shpbldg., Camden	1959	$14,000,000	1957	Talos
Oklahoma City	CLG 5	Beth Steel, SF	1959	$14,000,000	1957	Talos
Providence	CLG 6	Boston NavShpyd	1959	na	1957	Terrier
Springfield	CLG 7	Beth Steel, Quincy	1959	$13,986,000	1957	Terrier
Topeka	CLG 8	New York NavShpyd	1960	na	1957	Terrier
Long Beach	CG(N)9	Beth Steel, Quincy	1961	na	1957	Terrier, Talos, Regulus II
Albany	CG 10	Boston NavShpyd	na	na	1958	Talos, Tartar
Frigates						
Farragut	DLG6	Beth Steel, Quincy	1959	$52,429,000	1956	Terrier
Luce	DLG7		1960		1956	Terrier
MacDonough	DLG8		1960		1956	Terrier
Coontz	DLG9	NavShpyd, Puget Sound	1960	na	1956	Terrier
King	DLG10	NavShpyd, Puget Sound	1960	na	1956	Terrier
Mahan	DLG11	NavShpyd, SF	1960	na	1956	Terrier
Dahlgren	DLG12	NavShpyd, Philadelphia	1961	na	1957	Terrier
Wm. V. Pratt	DLG13	NavShpyd, Philadelphia	1961	na	1957	Terrier
Dewey	DLG14	Bath Iron Works	1959	$40,536,800	1957	Terrier
Preble	DLG15	Bath Iron Works	1960		1957	Terrier
Destroyers						
Gyatt	DDG1	(active)	---	---	1956	Terrier
Chas. F. Adams	DDG2	Bath Iron Works	1960	$44,045,600	1957	Tartar
John King	DDG3	Bath Iron Works	1960		1957	Tartar
	DDG4	NY Shpbldg., Camden	1960	$49,123,500	1957	Tartar
	DDG5	NY Shpbldg., Camden	1960		1957	Tartar
	DDG6	NY Shpbldg., Camden	1961		1957	Tartar
Henry B. Wilson	DDG7	Defoe Shpbldg., Bay City	1960	$34,445,243	1957	Tartar
Lynde McCormick	DDG8	Defoe Shpbldg., Bay City	1960		1957	Tartar
Towers	DDG9	Todd Shpyds., Seattle	1961	$18,487,400	1957	Tartar
	DDG10	Bath Iron Works	1961	$34,133,200	1958	Tartar
	DDG11	Bath Iron Works	1961		1958	Tartar
	DDG12	Defoe Shpbldg., Bay City	1961	$33,140,520	1958	Tartar
	DDG13	Defoe Shpbldg., Bay City	1961		1958	Tartar
	DDG14	Todd Shpyds., Seattle	1961	$17,819,924	1958	Tartar
Submarines						
Tunny	SSG282	(active)	---	---	1952	Regulus I
Barbero	SSG317	(active)	---	---	1955	Regulus I
Grayback	SSG574	(active)	---	---	1953	Regulus I,II
Growler	SSG577	NavShpyds., Portsmouth	1958	na	1955	Regulus I,II
Halibut	SSGN587	NavShpyds., Mare Is.	1959	$54,000,000	1956	Regulus I,II
Permit	SSGN594	NavShpyds., Mare Is.	1961	na	1958	Regulus II
	SSGN595	NavShpyds., Portsmouth	na	na	1958	Regulus II
	SSGN596	(Private yard, unassign.)	na	na	1958	Regulus II
	SSBN598	Electric Boat, Groton	1959	$105,000,000	1958	Polaris
	SSBN599	Electric Boat, Groton	1960	$85,000,000	1958	Polaris
	SSBN600	NavShpyds., Mare Is.	1960	$85,000,000	1958	Polaris

• *Tartar* **destroyers** — Fourteen guided missile destroyers (DDG) are in the current program, including the active "Gyatt," with her *Terrier* battery. The remainder will mount *Tartar*. Five DDG's have been requested in the fiscal 1959 program. The $44 million Bath Iron Works contract for the first two destroyers in the new construction includes $9.5 million for preparation of plans and other data for the whole class.

Although the heart of the future missile program is the Fleet Ballistics missile submarine, the Navy is continuing plans for *Regulus* II boats. Six are in the current program, and one nuclear powered *Reg* II boat is requested in the 1959 supplemental budget.

The three Fleet Ballistic Missile boats, designated SSBN, are to be followed by at least two and possibly six more in the 1959 fiscal budget. Only two additional SSBN's are provided for in the upcoming budget, but the House, after testimony by top Navy men, has voted money for six additional boats. This provides the nine-boat program the Navy testimony made clear that the service needs.

Thiokol Executive Dies

W. R. Ignatius, 52, general manager of Thiokol Chemical Corp.'s Longhorn Division, died at his home this week in Marshall, Texas. Ignatius joined Thiokol after a career in the Navy, where he became one of the country's top specialists in submarine construction and operation.

Ignatius joined Thiokol in 1950 as head of the statistical engineering department of the Redstone Division, Huntsville, Ala.

ARPA Puts Damper on Roles & Missions Battle

by Donald E. Perry

With a new approach to advanced research for space age weapons, a new defense agency now holds the key to whether the U.S. will match and surpass Russia in the arms survival race.

The agency is ARPA (Advanced Research Projects Agency), which promises to be more than just another acronymic extension to the Pentagon's long line of alphabetical agencies.

Born five months ago under Presidential pressure, and told to bring management to advanced research, ARPA has been christened with a healthy Congressional bankroll, and given far-reaching authority to bypass traditional chains of command.

Results: ARPA is succeeding where many have failed. It is adequately managing a nation's advanced scientific research program for tomorrow's weapons and military space technology, without fighting the Pentagon battle of service roles and missions.

• **Boss gets credit**—How is it being done? A good deal of credit goes to ARPA's boss, white-haired Roy W. Johnson, 53, who in April gave up a yearly salary in excess of $250,000 as a General Electric vice-president, to become director, at $19,000.

On his first day at work, Johnson made it clear that ARPA was not going to be an empire. He set limits on the number of people ARPA would hire. He received the enthusiastic support of the services by declaring the agency was a managerial team—it would not take over their research, their laboratories, or their facilities.

Johnson's tactics brought acceptance from an admiring Congress. An appropriations subcommittee, which normally is opposed to high-dollar funding for any new agency, regardless of purpose, promised $520 million in fiscal year 1959.

• **Across roles & missions**—The emergence of ARPA as the fair-haired agency quite naturally has resulted in the military services coveting many of its assignments. But so far, ARPA has resisted most advances and is assigning research tasks to the individual services depending on their capabilities.

And the services—at least on the surface—harbor no resentment. Many service leaders have openly said the agency is performing a real role in preventing duplication and waste.

ARPA is critically aware that with the constantly increasing cost spiral for modern weapons, the nation can



Wide World

Roy W. Johnson . . . he provides management for research . . .

ill afford to create and operate duplicate weapon system complexes that can perform similar missions. And, it is just as aware that individual services should be permitted to follow parallel courses toward objectives, for competition is still important.

The Defense Department admits its has produced too many missiles and other advanced weapon systems. A reason: key decisions were not made in the early stages of research and development.

This is ARPA's job, and with less than 35 scientists and management experts, it is making daily decisions on research projects before permitting them to go into costly production.

In the past, many forward-looking research programs were retarded by the necessity for a formal military requirement. ARPA has changed this. No longer is U.S. military science tied to a specific weapon objective.

ARPA is free to explore scientific areas 10 to 15 years in the future which may lead to a better weapon, and prepare for defense against any surprise enemy weapons that may come. This, many defense leaders feel, is giving the nation for the first time a military science that can compete with Russia, which for years has not tied scientific research to a specific objective.

• **Agency assignment**—ARPA today has three general assignments: military space science and technology; development of a ballistic missile defense; and research in propellent chemistry. The President or Secretary of Defense will assign additional tasks.

Pending passage of legislation which will form the National Aeronautics and Space Agency, and the capability of NASA to carry out programs for peaceful exploration of space, ARPA is doing the job. The coming lunar probes using *Thor-Vanguard* and *Jupiter-Sergeant* combinations is one purely scientific task ARPA is doing for NASA. Another task which probably will be given to NASA is the development of high-thrust, on the order of one million pound chemical rocket engines. The military, at this time, has no operational requirement for such an engine.

• **How to cut waste**—How is ARPA preventing wasteful duplication? It reviews, programs, directs, and expedites advanced research. It deals directly with the operational service element which will perform the research without going through time-consuming channels of command.

By holding advanced research purse strings, and simply transferring the money as needed to the responsible service, ARPA can make its decisions effective. In dealing with industry or educational, research, or scientific institutions, ARPA requests a military contracting organization to execute and administer a contract. Or it can execute a contract and "farm it out" to one of the services for administration.

ARPA did this for its lunar probe project. In 12 days (m/r July 7, p. 9) orders were issued direct to Air Force and Army operational elements. Normally, it would have taken months.

When an ARPA project passes beyond the research and development stage, ARPA assigns it to one or more of the military departments for engineering, production and operation. Here comes ARPA's real test.

For, if a military department takes issue with an assignment of some project to a sister service in the perennial roles and responsibilities arguments, it has the right of appeal to the Secretary of Defense. So far there have been no major difficulties, but Johnson feels there can be.

He's not worried though, because the agency is growing in technical competence. "I have no qualms about getting the right answer and being able to pick the right one," Johnson says.

Johnson already has made one choice against the Air Force, which eventually will get more than 50% of ARPA funds. He's made it stick, too. For research on the *Pied Piper*, or *Sentry* military reconnaissance satellite, Air Force asked for $215 million. ARPA came up with a $152 million figure.

Operation *Gaslight:* Anti-Missile Breakthrough

The Army has made a major breakthrough in anti-missile missile research.

In an exclusive interview with m/r, Dr. Ernst Stuhlinger, Director of the Research Projects Laboratory at the Army Ballistic Missile Agency in Huntsville, Ala. said, concerning the studies of the Jupiter re-entry May 18:

"One of the most important things we learned during 'Operation *Gaslight*' was how to discern a warhead from a missile body as it re-enters the atmosphere. This is extremely important from an anti-missile standpoint."

Dr. Stuhlinger was referring to the photographic, spectrographic and radiometric studies made of the re-entry.

The photographic studies were made from a destroyer escort ship loaned by the Navy. The photographs show three brightly glowing objects: The nose cone, the booster or missile body and finally, the instrument package. They appeared at practically the designated position, re-entering the atmosphere in single file.

"Within three seconds after the first re-entry light was observed," the official ABMA report said, "the phenomena had blossomed into three distinct objects. The brightest object, which was assumed to be the booster, appeared similar to a huge magnesium flare. The light emitted by this object definitely pulsated."

The brightness of the booster was estimated by observers to be 1,000 times that of the planet Jupiter.

Ahead of the booster was a smaller light, caused by the nose cone's re-entry. The third and final section, the instrument package, was the first to burn out.

Of significance also was the re-entry of the three components in the impact area, with the nose cone falling within 30 miles of the picket ship. The picket ship could have been closer if damage was not a consideration.

• **Added significance**—Further findings of "Operation *Gaslight*" which are considered new and highly significant discoveries in identification and re-entry problems heretofore considered immensely difficult to solve, Dr. Stuhlinger said, include:

"From these experiments we wanted to find out what happens to the re-entry bodies temperature-wise, both from a color and intensity standpoint. That is, what sort of heating processes occur in the atmosphere layer immediately surrounding the re-entering body."

Dr. Stuhlinger went on to say that from the studies, it was learned that the temperatures in the boundary layer are extremely high. In fact, the radiation (electromagnetic energy) from all portions of the spectrum, including both the visible and the infra-red, was so high that it saturated some of the instruments. Many of the photometers and the radiometers were driven off scale by the intensity of the radiation.

"It is not possible to simulate in ground experiments the high speeds, the densities, and the extremely high temperatures," Dr. Stuhlinger said," therefore it is essential to continue to make the experiments in real flight, photograph them and evaluate the photographs to determine the distribution of temperatures in the boundary layer."

"Operation *Gaslight*" was directed by David D. Woodbridge and Ray V. Hembree, two of Dr. Stuhlinger's assistants at ABMA. The team aboard the picket ship included scientists and other personnel from Barnes Engineering, Stamford, Conn. which was chosen by ABMA to perform the spectral and radiometric measurements; AVCO Research Laboratory; Aerojet General Corp.; and Air Force Cambridge Research Center.

Among special instruments designed by the Stamford firm for use during the operation was a meteor-type spectral camera. The camera employs six individual cameras to attain a view of approximately 70° vertically and 100° horizontally. The huge complicated arrangement was stabilized on board ship by mounting it on one of the five-inch gun mounts, and using the ships gyroscopic control to the mount to counteract the roll and pitch of the vessel. Other instruments included specially designed radiometers. The spectacular photographs of the three components of the *Jupiter* re-entering the atmosphere were made by a hand-held 35mm motion picture camera.

Color-wise, the radiation of the booster was like a magnesium flare, the instrument package in the visible spectrum was blue and the nose cone an orange-red. All three passed behind a cloud shortly before the nose cone plunged into the sea with the radiation from the missile parts illuminating the whole cloud.

The successful recovery of the nose cone demonstrated that such a cone is capable of incorporating a nuclear warhead and protecting it from destruction by the aerodynamic heating upon re-entering the atmosphere. (Editor's note: See m/r next week for picture story of "Operation *Gaslight*")

Urge Reorganization of ARDC

To overcome a "growing lack of trust" in the capabilities and performance of individuals and companies at the working level—a phenomena that has increased expenses and duplication in management—the Air Force must revamp its research and development operations.

That was the report to the Chief of Staff of the Air Force, contained in a long-awaited report of the so-called Stever Committee—a scientific advisory board chaired by Dr. H. Guyford Stever, associate dean of engineering at M.I.T.

In a summary of his committee's findings after long study of R&D activities, Stever also called for:

1. A sharp reduction in administrative control and detailed technical direction exerted by higher echelons, both within and without the R&D chain of command;

2. Reorganization of ARDC along functional lines—policies, resources, requirements and program evaluations—with deputy commanders in charge of each functional division;

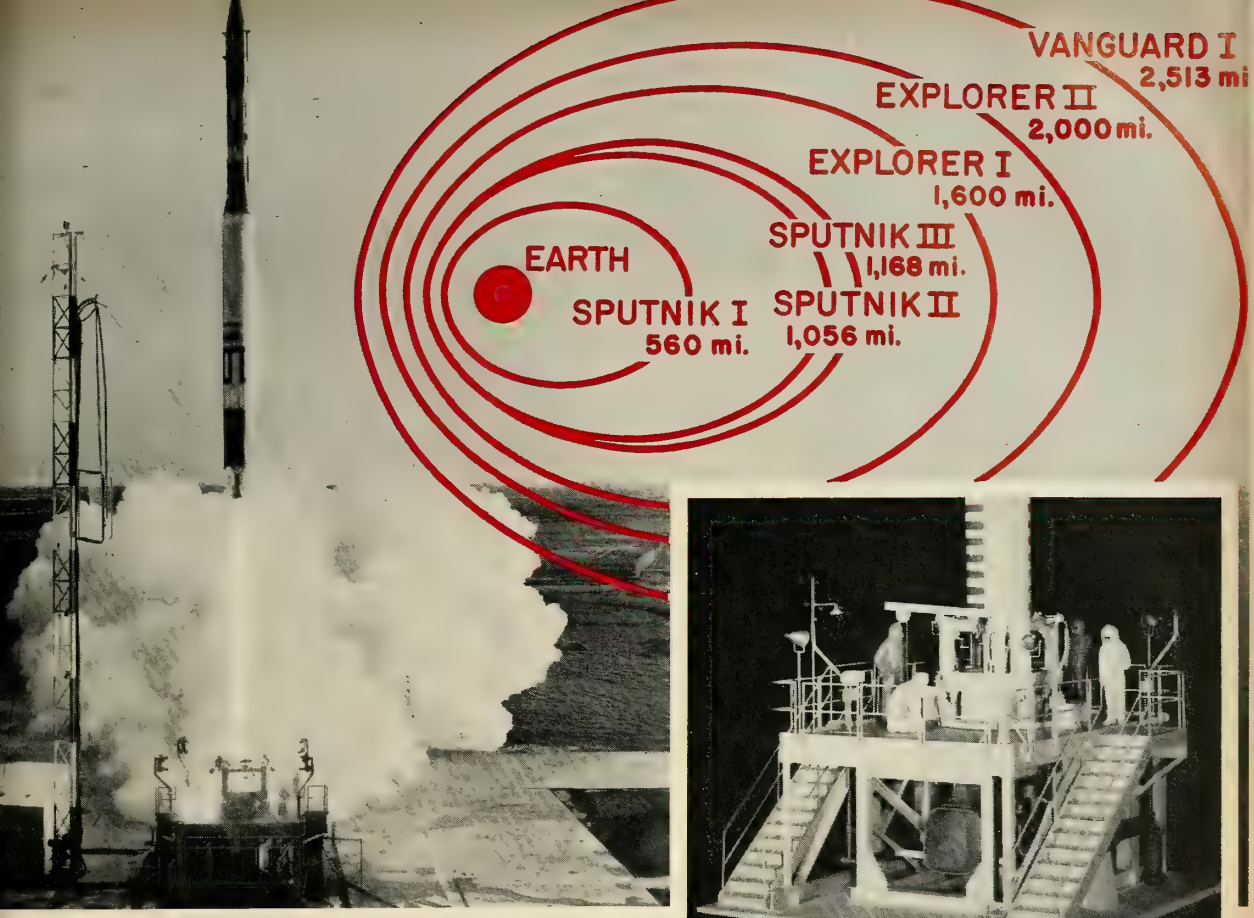
3. Substantial increases in budget for research, state-of-the-art development and development of radically new weapons, and all R&D appropriations to be placed completely under the Deputy Chief of Staff, with ARDC designated as the procuring activity;

4. Expansion of the concept of giving R&D a "package"—funds, facilities and personnel;

5. Give more incentive to contractors doing R&D work.

Commenting on the "lack of trust" statement, Stever said:

"There is a growing lack of trust in capability and performance of individuals at the working level . . . not only in the Air Force but throughout government. This has resulted in taking away from the working level authority, but not responsibility, for R&D, increased staff work, increased detailed technical direction, increased constraint in use of money, people and facilities, and resources required. Lack of trust is extended to contractual relations. Unless this trust is restored, the Air Force cannot hope to reduce the length of its development cycle."



Vanguard I being launched into orbit from Loewy-Hydropress flight-firing installation at Cape Canaveral, Fla.

Scale model of Loewy launching platform and rocket stand.

Loewy launching installation helps boost American moon to highest altitude of all satellites

On March 17, the Navy's Vanguard rocket, built by The Martin Company, soared from its Loewy-Hydropress launching installation into the blue and into orbit at the greatest altitude of all satellites—2500 miles from the earth at apogee.

When Vanguard misfired, on December 6, 1957, in this country's first attempt to put up a satellite, the conflagration could have completely destroyed the launching facilities. But Loewy had designed and built them so well that damage was extremely limited. The fire-fighting system released a torrent of water fog to combat the intense heat of the burning rocket fuels. Within an hour of the mishap, Loewy engineers were assessing the damage and lining up repair crews. Within a week, the static and flight-firing facility was repaired, and Vanguard's second stage was erect and under test. One more week and the first stage stand and weight recording system were completely repaired and operational.

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What's the Law in Outer Space?

What are the legal elements in the international control of outer space?

Arnold W. Knauth, a member of the American Bar Association's Committee on the Law of Outer Space, discussed the problems the Committee is facing in an address before the American Association for the United Nations, Washington.

Knauth summarized the types of law that might be applied to outer space—natural law, positive law, public law and private law. He pointed out that natural law is the law of man's conscience, and in that sense, it does not exist unless men are present. "Nature's laws presumably exist in outer space, but there will be no natural law there until men arrive," he said.

Positive law is made by legislative bodies. In the sense of outer space, there would most probably be positive law in international legislative acts and national legislation.

Private law is of no practical importance in outer space, Knauth stated, as no business relations or contracts are being committed there in the present. "When the law of outer space is considered, therefore, it is not a system of private law between man and man as exists on earth, but rather of international law in the public sense."

• **International control** — Knauth outlined aspects of the public international law of outer space, as suggested by the Committee:

a. Objects hurled by human beings into outer space should be catalogued and registered; their characteristics recorded and reported.

b. For the present, the gathering of samples and picking up objects in outer space is like fishing on the high seas—"free to anyone who cares to go to fish."

c. Rules of the road to prevent the interference of paths of the various satellites. "To date," Knauth stated, "there are not enough facts to construct a legal system of the law of collisions."

Other considerations mentioned by the Committee—if a space vehicle fails, should the manufacturer be liable?

Also, what is the possibility of criminal law as it affects outer space? "The launching of every satellite is due to a human hand and will on Earth," Knauth said, "and it could be an offense to launch an unregistered and unlicensed satellite, and to cause a satellite to do various things which are damaging to the inhabitants of the Earth."

• **International cooperation**—Insofar as the laws of outer space deal with international cooperation, Knauth outlined the political, economic, social and defense elements which must be considered:

a. Politics will be controlled on Earth, and not in outer space. "As far as we know," Knauth said, "there will not be nationals claiming to have been born or naturalized in outer space for some time to come."

b. Economic interests in outer space have not been explored, and therefore are still unknown.

c. Social interests are also largely on the Earth's surface, rather than in outer space. "Again," Knauth said, "in order to have social interests, there must be inhabitants."

d. Defense interests, as suggested by the Committee, might be broken down as follows: Sovereignty of outer space extends no further than the point at which an object propelled outwords comes down again. Anything beyond that point might be controlled by the U.N. A U.N. agency will register and license satellites, space platforms, and any other vehicle that may be designed for entering space.

Any man who puts anything from the Earth's surface into space without registration and license will be a "pirate" subject to universal jurisdiction. "In other words," Knauth stated, "space activity will be subject to a U.N. veto."

• **Veto control**—In the U.N., there soon will be a small handful of members possessing the ability to shoot into outer space. However, a large majority will not possess such abilities, and may wish to veto all further space exploration.

Those with the ability and the will may go ahead; however, launching of a satellite will have to be kept secret. "Therefore," Knauth pointed out, "in all probability the veto is an unwise idea; better to seek simple publicity than to foster a situation which would encourage secrecy."

• **Constitutional control** — Knauth also brought up the problem of the U.S. Constitution as it might apply to the sovereignty of outer space. Three suggestions named by the Bar Association member are as follows:

To amend the Constitution to declare that U.S. sovereignty does not extend beyond some particular altitude; to amend the Constitution that sovereignty over outer space may be managed by the U.N.; or to obtain a decision in a Constitutional manner that the sovereignty of the U.S. in space has a top limit.★

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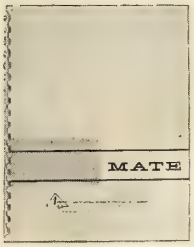
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One of the nation's newest classified missiles will utilize this miniaturized resolver-servo assembly as an integral part of its guidance system.

Contained in a pressure-sealed 2-inch cube of aluminum are all these miniaturized components: dual anti-backlash gear train—slip clutch—size 11 temperature compensated resolver—motor generator and precision potentiometer. Each of them was designed and built by Edison.

The entire sub-system was produced in prototype by Edison in less than four weeks —a speed record and an example of Edison's design and production potential.

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The Edison systems teams mean better designs produced more quickly.

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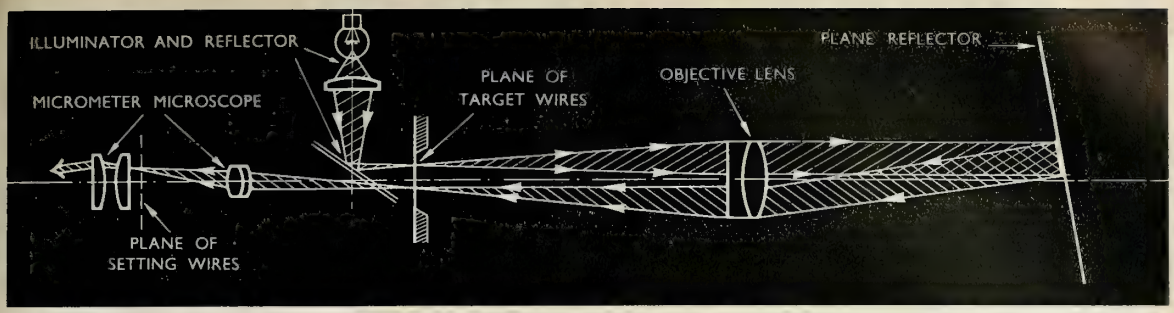
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A MICROPTIC AUTO-COLLIMATOR consists of a telescope with a pair of cross-wires set in the focal plane of the objective lens and illuminated. Light emerges from the lens as a parallel beam, and projects onto a plane reflecting surface. The reflected beam is received back into the optical system, forming an image of the cross-wires in the same plane as the cross-wires. Displacement of the image is measured to an angle of tilt of the reflecting surface, as little as 1/10 second of arc.

Optical Checks Reduce Tooling Costs

by Peer Fossen

THE FACT THAT LIGHT TRAVELS in a straight line may have far-reaching effects on the economics of the national rockets and missiles program. Costs are forcing abandonment of the shotgun approach to missiles development. The program has become selective, not only as to *what* shall be developed, but *how*.

While no one instrument has a monopoly on measurement and alignment, optical tooling provides a unique opportunity to the engineer. And of the optical tools available, the auto-collimator is one that can help do two things: achieve greater precision in components and in assembly of those components—and reduce costs.

The essential considerations of parts and assembly precision derive from the basic question: "Will it work?" ie., "Will it hit the target?" With air-to-air missiles costing from $1,200 to $50,000 each, this is no idle question.

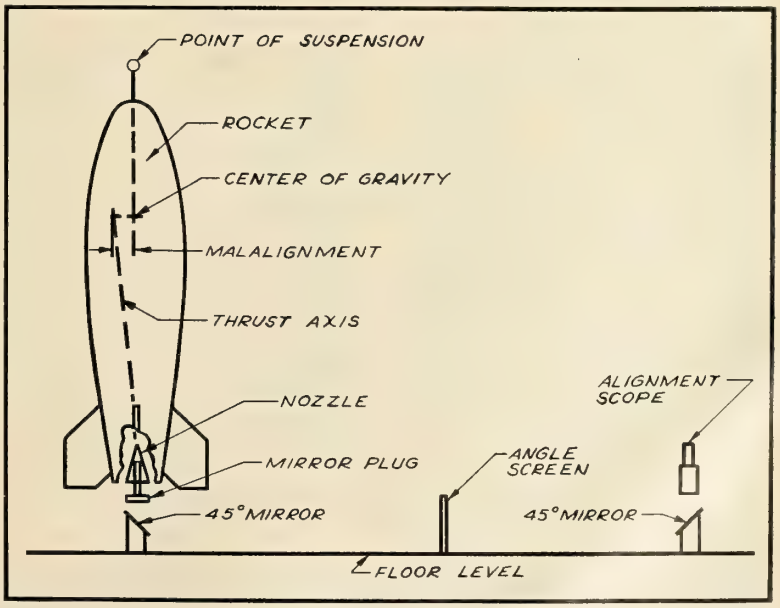
Every engineer is familiar with the way tolerances multiply through a series of production processes, and that the closer the end-tolerances or the fit tolerances, the finer the process tolerances must be, and the more costly the machine or bench operation.

Such demand for eventual accuracy means that attention must be paid to problems of alignment in constructing the missile to avoid thrust troubles due either to mis-location, or to the tolerances and fits of the internal components. It means that care must be taken in the alignment, tolerance, and fit of guidance mechanisms. Also, attention must to paid to alignment in ground support mechanisms, to say nothing of the alignment problems involved in aiming and firing the missile itself.

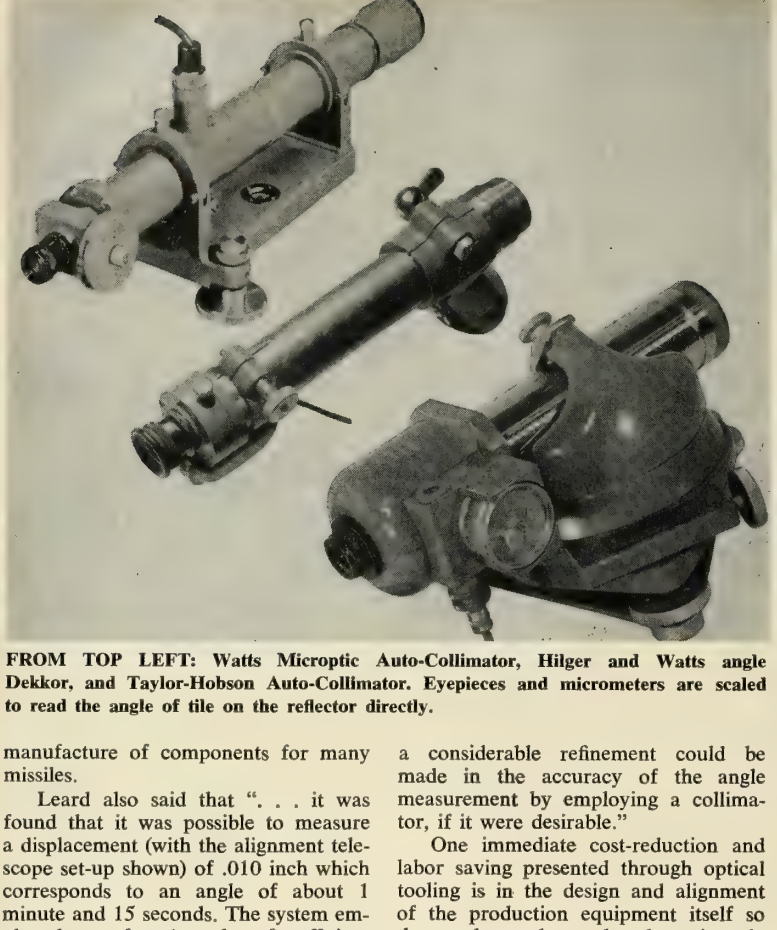
• **Why optical?**—One of the simplest illustrations of missile alignment problems is shown in a schematic of an optic test for rocket thrust malalignment, described by R. M. Leard, Head, Quality Engineering Division, Engineering Department, U.S. Naval Ordnance Test Station, in a paper presented to the American Ordnance Association.

According to Leard: "Limits on the alignment of components . . . generally take the form of a tolerance on the angle between the axis of the nozzle cone and the seating surface of the nozzle plate, as well as squareness tolerances on the ends of the motor tube. Tolerances are rather close on these angles, because the variation in angle will be multiplied many times, as the center of gravity of most rockets is well forward."

Leard's group use an auto-collimator to check the squareness of nozzle axes to their seating shoulders individually. Optical tooling, including the auto-collimator, is also used in the



ALIGNMENT TELESCOPE measures thrust-to-rocket-axis by means of angle screen and mirrow plug. Accuracy is on the order of an angle of 1 minute, 15 seconds.



FROM TOP LEFT: Watts Microptic Auto-Collimator, Hilger and Watts angle Dekkor, and Taylor-Hobson Auto-Collimator. Eyepieces and micrometers are scaled to read the angle of tile on the reflector directly.

manufacture of components for many missiles.

Leard also said that ". . . it was found that it was possible to measure a displacement (with the alignment telescope set-up shown) of .010 inch which corresponds to an angle of about 1 minute and 15 seconds. The system employed was found to be of sufficient accuracy for the measurements desired, however, it should be pointed out that a considerable refinement could be made in the accuracy of the angle measurement by employing a collimator, if it were desirable."

One immediate cost-reduction and labor saving presented through optical tooling is in the design and alignment of the production equipment itself so that work may be produced consistently to repeatable tolerances. Grinder and planer manufacturers have found that the use of optical tooling has cut down costly hand-scraping of machine ways. It has also enabled them to build machines whose performance accuracies are far greater and more dependable.

With optical tooling, for example, Barber Colman Co. produces the Hendey Lathe, with a headstock spindle mounted in a casting on three bearings, the centers of which are in line and concentric to within .00015 inches. Rockford Machine Tool Co. produces hydraulic planers which plane directly to less than .001 inch.

• **Another use**—Machine tool builders know that "good enough" is no longer good enough—that their machines must always be better in order to produce better.

Several years ago, Northrop Aircraft, Inc., faced the problem of cutting missile gears to a tolerance of plus or minus five seconds of arc. Incremental cutting methods were used to eliminate the normal gear-train errors from the gear cutting process.

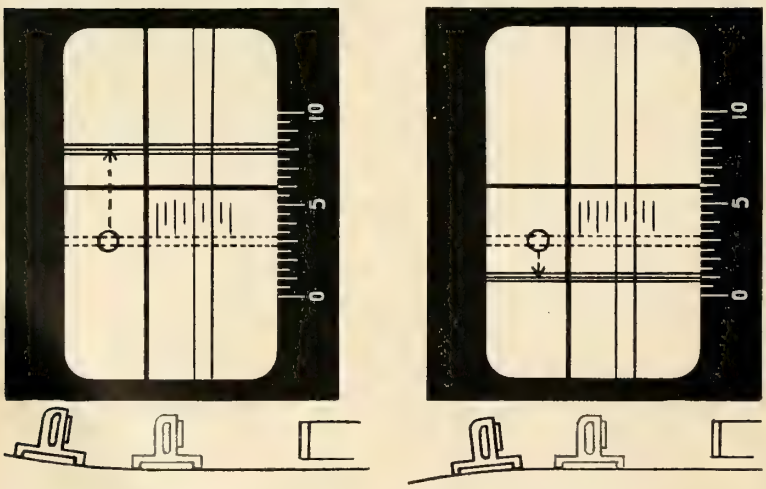
According to R. E. Gagon, Northrop senior engineer, this was done because "long range missile and guidance control systems require gears of unusual accuracy. Missile control is influenced by angular shaft movement. A very small error in angle may produce a very large lateral or longitudinal error in trajectory."

In the original process, angles were assembled with angle gage blocks and checked with a Hilger & Watts Microptic Auto-Collimator. However, to remove the errors introduced by improper wringing of the gage blocks, the Northrop optical laboratory prepared glass angle blocks ground and polished to the required angle with an error of less than half a second of arc.

The accuracy of these blocks could be demonstrated directly with the Microptic Auto-Collimator, since the instrument reads directly to a tenth of a second of arc. This instrument was used, together with a microptic circular table and other supporting optical and mechanical equipment, to calibrate the sector gears required for prototypes and early production runs of the product.

Routine production machine inspection by optical methods can support quality control procedures. In some instances, optical measurement can be used effectively to check prototype parts while production methods are being developed.

• **How it works**—The importance of the auto-collimator in precision measurement and alignment of rocket and missile components springs from the fact that precision measurements—on the order of half a millionth of an inch per inch—can be made without



"Plus" Readings **"Minus" Readings**

CROSS-WIRES are represented by heavy, black lines. Thin vertical and parallel horizontal lines are the setting lines. Regardless of original setting lines, this reading on the micrometer drum becomes datum.

gage blocks or complex measuring instruments, by using the principles of auto-collimation and geometry.

Essentially, an auto-collimator is a telescope, incorporating a lens system from which light emerges in a beam of paralleled rays. The light passes through a reticle containing cross-wires, and is projected out onto a plane reflecting surface, usually a front-surface mirror.

The reflected beam is simultaneously received back into the optical system, forming an image of the cross-wires in the same plane as the cross-wires. If the reflecting surface is tilted, the returning beam is deflected through twice the angle of tilt, and the image of the cross-wires is displaced proportionately.

The position of this image is, of course, independent of distance, which makes it possible to measure widely-spaced locations. The displacement of the image is observed in the eyepiece, against a scale, and measured by an optical micrometer reading directly to 1/10 of a second of arc, which represents roughly half a millionth of an inch per inch.

Although the values produced by the auto-collimator are angular values, they are quickly converted into linear measurements through simple trigonometry. The instrument is thus not only enormously sensitive, but quite versatile. Its use and versatility is greatly increased by such accessories as the optical square or penta prism, the various optical polygons, and other devices.

The other factor which gives the auto-collimator such a high degree of precision is its self-checking capacity. The quick and convenient reversal of a set-up involving reflector, optical square, or other accessories, provides a simple 180° indexing of the measurement so that any errors may be meaned out. In the same fashion, the auto-collimator may be used to check all of its own accessories as well as other optical (or mechanical) measuring instruments.

The Hilger & Watts Microptic Auto-Collimator is distributed in the U.S. by Engis Equipment Co., Chicago.

• **Future use**—Further developments in optical tooling have taken place along the line of projection-type equipment, where the cross-wires or scales in the target are no longer observed through an eyepiece, but are projected on a screen as an enlarged image. Result is, with suitable fixturing, rapid piece-part inspection with precise optical measurement is becoming commonplace on the production line.

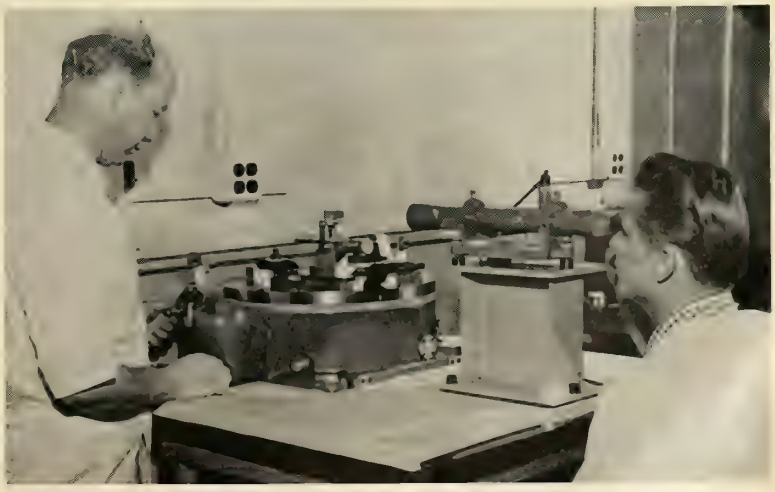
Optics has been felt in new concepts of specifications, in the development of production methods to meet those specifications, in gage control, and in production parts inspection.★



CHECKING SURFACE PLATES for flatness. Here is a typical arrangement. A Watts Microptic Auto-Collimator, corner mirror, and mirror carriage is moved along the line being read for flatness. Demand for more and more precision in missile engineering today makes laboratory equipment, such as surface plates, a critical item in measurement and check-out of precision components.



INSPECTION OF PRECISION MISSILE GEARS at Northrop Aircraft comprises a primary and secondary optical system. This allows a two-way check of the indexing system, and holds it to a tolerance of 1/10 second of arc (half a millionth of an inch per inch). The operator is shown using an auto-collimator to readjust the machine's calibration every 7½ degrees of carriage travel to correct any accumulative error. This installation is perhaps the most accurate indexing system in use in the U.S.



TECHNICIANS from Northrop Aircraft check high-precision missile gear with Watts Microptic Rotary Table and Watts Microptic Auto-Collimator. The Auto-Collimator is sighted into surface mirror, attached to the spindle of the table at the fulcrum point of a master work gear. Variance is held within close tolerance. Tolerance build-up in conventional gears causes serious problems in missiles.

Neon "Sign" May Map Radiation Belt

Satellite Proposed to Place Gas In Order That U.S. Scientists Can Plot Danger Zone for Man

by Savo Coric

A NEON "SIGN" in the heavens may be the best means of measuring the extent and density of a band of heavy radiation that could block manned space flight.

The radiation belt—detected by Geiger counters in *Explorers* I and III —is estimated by Dr. James Van Allen, who advanced the theory of a radiation belt, to stretch from 600 to 8,000 miles from the earth. According to this theory, the belt is probably a plasma of protons and electrons—particles of ionized hydrogen atoms ejected in space by the sun and held away from the earth by the earth's magnetic field.

To measure this belt, and the ion concentration of the plasma, would involve the installation of a vessel containing a compressed gas, preferably neon, in a future satellite. This vessel would be constructed so as to allow its contents to be ejected into space upon a signal from a Geiger counter, and heat or light sensing device.

The mechanism for opening the vessel would be preset to function only when the satellite's Geiger counter registers a counting rate considerably above normal, and the satellite is in the shadow of the earth.

• **Creating a glow**—Upon leaving the vessel, the gas would expand, be bombarded and excited by the electrons of the plasma, and then emit its characteristic bright red/orange glow. This glow would probably be visible from earth with the naked eye, providing the satellite emits a large enough amount of gas.

This artificial aurora borealis would be easily discernible from the natural one because of its red/orange color, its location along the satellite's orbit, and because it would not be confined to the polar areas. The rate of expansion of neon gas in the belt, easily observable from earth, will lend itself to measurement, or at least to an evaluation, of the original ion concentration in the radiation belt.

This rate of expansion is a function of both the temperature of the belt and the density of the hydrogen ions which push the neon atoms violently around. While the first of these is measured by appropriate temperature instrumentation aboard the satellite, and radioed to earth, the second can be deduced.

Even the shape of the brilliant neon cloud and its deviation from the satellite's orbit could indicate a great many things about the currents of charged particles around the earth in this radiation belt. These currents are supposed to provoke the disturbances in the earth's magnetic field one or two days after a period of increased activity of sun spots.

In this case, the mechanism for releasing the gas from its container can be activated upon a command signal from earth, to enable its use at any desired time, such as increased solar activity.

• **Shows punctures**—This phenomena can also indicate when a satellite orbiting in the belt has been punctured by meteors or if its transmitter suddenly ceases operation. (This happened to *Explorer* III in May, and it was presumed that meteors had punctured its hull and knocked out the radio equipment. However, the satellite resumed transmissions later.) Now, every satellite is filled with gas for maintaining internal temperatures within tolerable limits, so that the gas will escape into space in event of a meteor puncture, and thereby indicate the presence of such a puncture.

In addition to the primary objective of investigating the theorized radiation belt around the earth, this method also offers a means of simply and efficiently exploring the depth of the radiation belt around the moon, if there is one.

The existence of a belt would tend to prove that the moon also possesses a magnetic field, which in turn would help explain why the earth has a magnetic field. To date, there has been no satisfactory explanation of this phenomenon.

This detection of the moon's radiation belt would be done in a similar manner to that already described, but with two modifications. First, there would have to be a timing device which would connect the Geiger tube to the gas-releasing mechanism only when the moon-rocket is within the moon's radiation belt, not when it is passing through the similar belt around the earth.

Secondly, observation of the glowing gas could be done only with telescopes or by spectroscopic means, unless an enormous amount of gas is released.★



THE EFFECT OF A METEORITE PUNCTURE of a neon-gas-filled satellite would be similar to that shown in this NACA photo. The radiation belt surrounding the earth would act on the neon and make it glow as it rushed from the satellite. Deliberately releasing large quantities of neon in this belt would cause a large glowing area in the sky and permit observation and measurement of the area.



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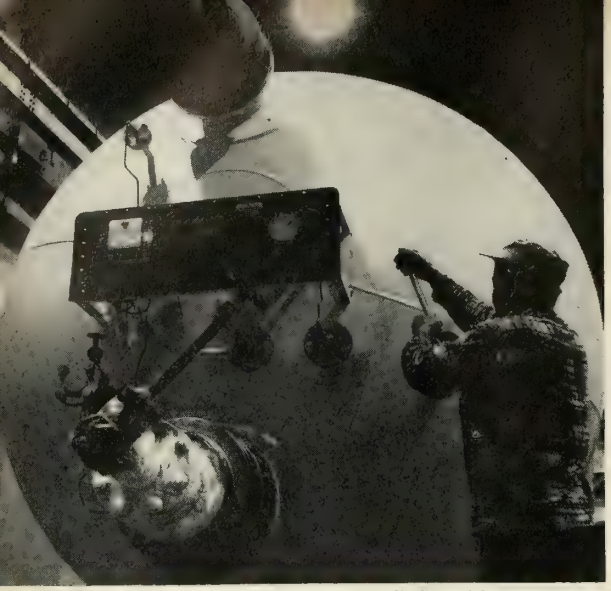
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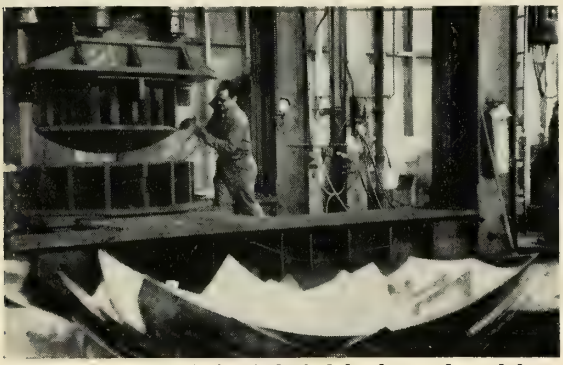
Huge LOX Tanks:

A Cold Problem In A Hot Business

Photography by Seabrook Hull



HERE ARE THE WORLD'S LARGEST airborne storage vessels. The business end of *Thor's* 13,500 gallon capacity liquid oxygen loading tank shows the size of the fabrication job. Cambridge Corp. builds tanks for Douglas Aircraft.



SEGMENTS of tank's hemispherical heads are formed by a 500-ton hydraulic press. These LOX tanks are giant double-shell dewars with a high vacuum between the shells.



A WELDER works in the shadow of completed hemispherical head assemblies. These tanks, despite their size, are completely air transportable in currently available aircraft.



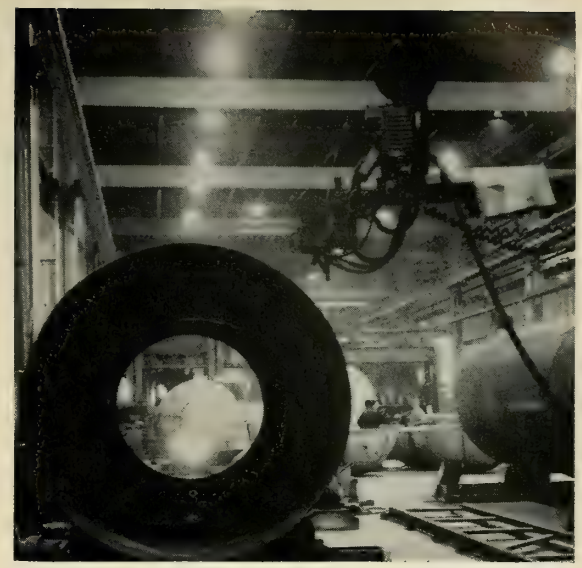
SPECIAL JIGS AND FIXTURES, such as this welding positioner, are needed in assembling stainless steel inner and aluminum outer shells.



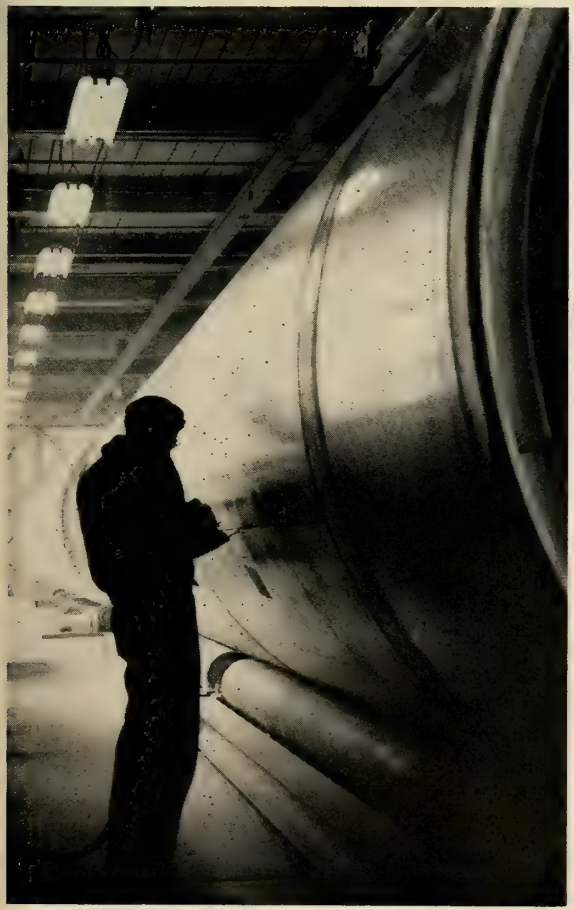
SEGMENTS of the hemispherical head are being fitted together on a welding positioner. Tanks such as these will accompany *Thor* squadrons overseas (to Britain) this fall.



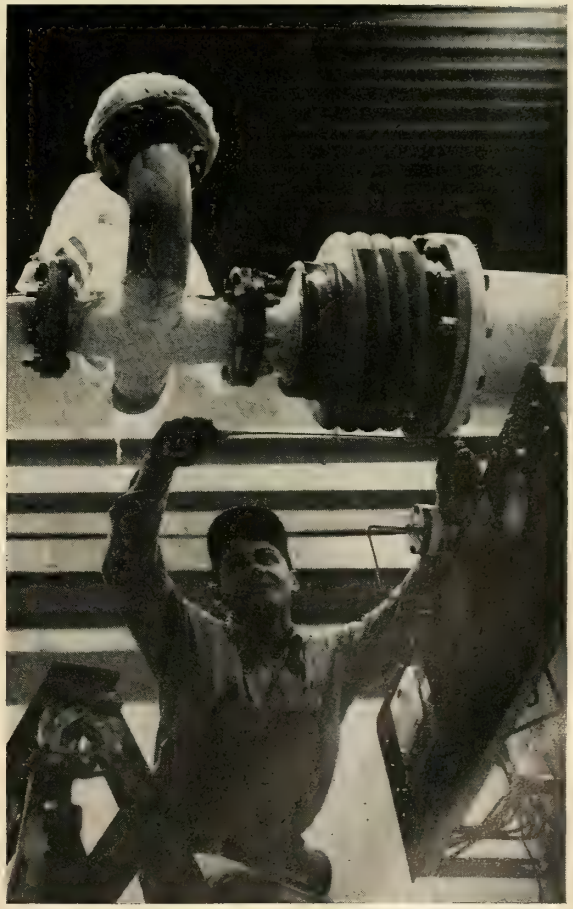
CLEANLINESS is an absolute necessity, not only to assure structural integrity, but to preclude any contamination of the liquid oxygen. Here oxides are removed prior to welding.



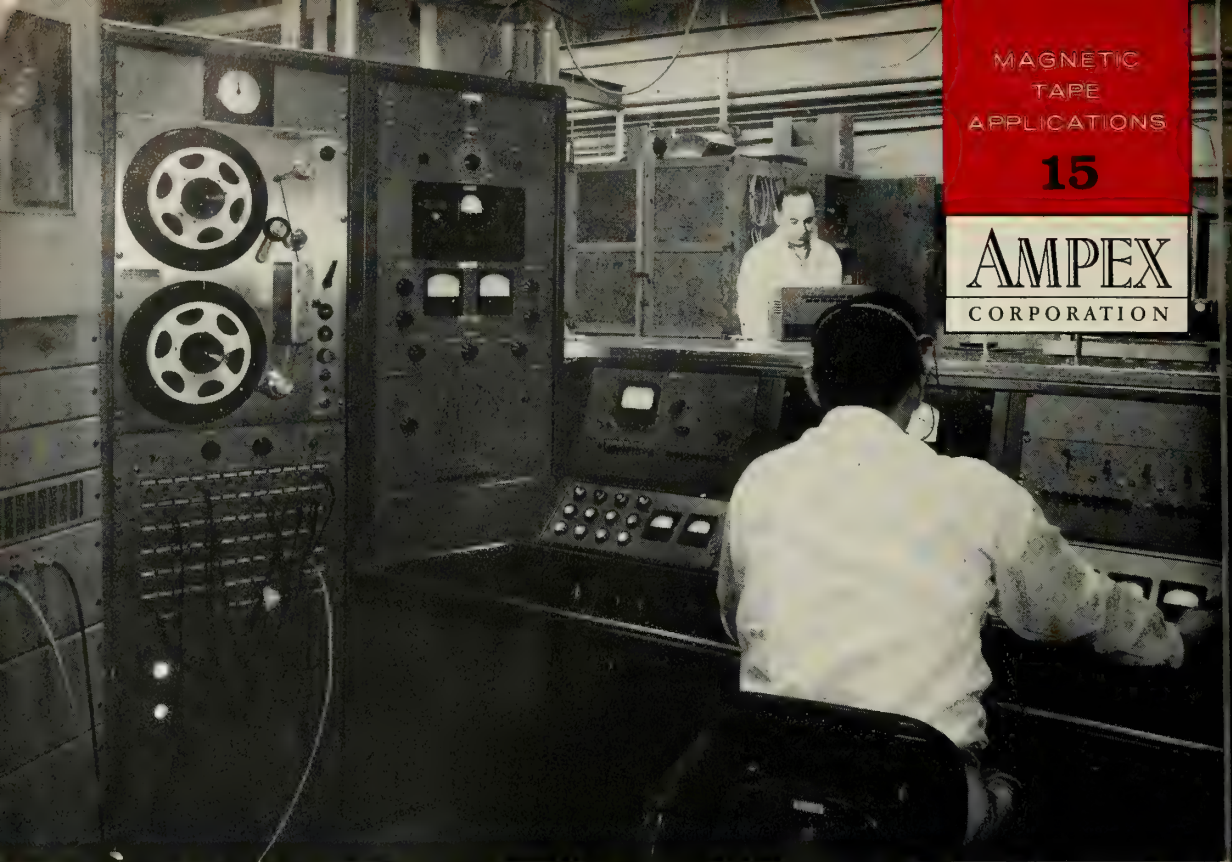
STAINLESS STEEL inner shell sub-assemblies for huge tanks. Automatic welding head in the upper foreground is an example of the kind of fabrication required.



THERE CAN BE NO LEAKS in the evacuated area between the two shells. Here, an inspector checks the condition of welds in the outer shell of aluminum plate.



VENT LINE expansion bellows must be carefully inspected during liquid nitrogen run-down test. Note the ice that has formed on the equipment. Tank is ready for shipment.



How to improve component reliability by better shake tests

Magnetic tape simplifies complex-wave testing and lessens human error



Many of the components that got their first ride on this tape-driven shaker are now circling the sky in Explorer I, our first successful earth satellite. It is highly significant that the California Institute of Technology Jet Propulsion Laboratory which led the development work on this satellite also pioneered complex-wave vibration testing. In this technique, magnetic recording plays many vital roles.

THE WAY TO OUTGUESS THE UNKNOWNS

Is simple sine-wave vibration testing sufficient? Or is a closer simulation of the missile's actual vibration environment a necessity? Results are not the same. Sinusoidal simplification often demands knowledge more complex than the complexities of a realistic test itself. Rocket components can bear neither the weight of excess safety factors nor the risks of conjecture – reasons why JPL chose random noise and complex waves.

Telemetered vibration tapes from actual missile flights are often used on shakers to assist development of test procedures. But this is not a complete answer. Different flights yield different vibration environments. A more ideal test-programming tape is a synthesized composite or envelope of the more severe conditions from many flights. This tape often combines random noise of engine vibration and complex waves from aerodynamic properties and structural resonances. And just as the missile's mass, velocity and surrounding atmosphere will change rapidly with time – so the taped program must change too.

Once on magnetic tape, any test program stays intact. It is repeatable without tedious setup and time-varying control of separate signal sources. With a properly calibrated tape, there is little chance that an operator will accidentally create destructive forces by errors in frequency or gain settings. Tape eliminates many possible sources of human error. It also leaves personnel free to concentrate on other requirements of shaker operation and test observation.

TAPE PASSES ALONG THE "IDEAL" TEST

So that co-contractors and subcontractors will run desired shake tests correctly on the components they furnish, Caltech's JPL frequently sends them program tapes. These contain calibration data in addition to the program itself. Thus a similar shake-table setup on the other side of the country can exactly duplicate the tests run in JPL's own laboratory. The tape lessens chance of misinterpretations and additive safety factors.

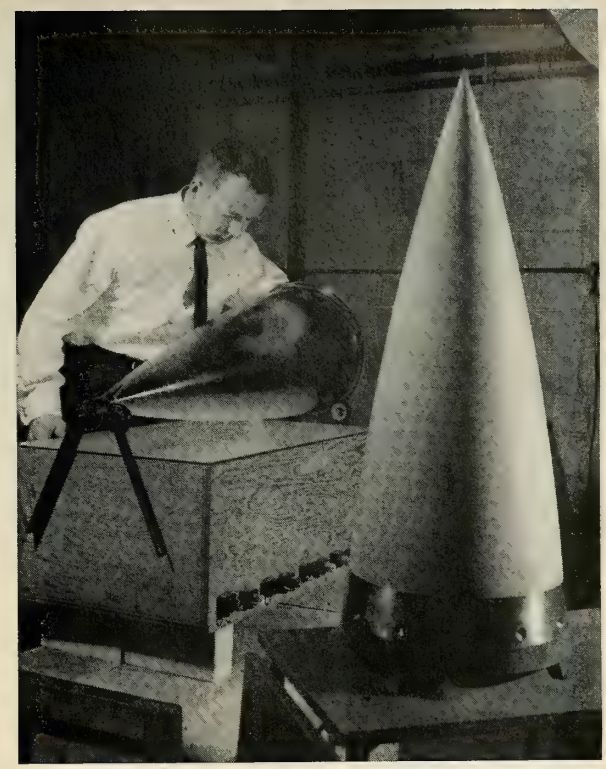
As quantity production of missile components gets under way, magnetic tape offers a means to run optimum shake tests on large numbers of components at widely separated manufacturers. From copy tapes, test programs of complex waves can be run almost as easily as a simple sinusoidal scan. Individual users need not have equipment to generate their own shaker-control programs. Prime contractor or research co-contractor can furnish the tapes. And since any number of duplicates can be made, a well-conceived test program can have unlimited circulation.

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Glass-ceramics— New Vista for Radomes



A MAJOR ADVANTAGE of the glass radome material is its transparency before the ceraming process, thus affording visual inspection opportunity.

by Norman L. Baker

DERIVATION of the word radome is simple—merely join two words,—radar and dome—basically explaining the function. A more precise definition might be: a radome is an enclosure which permits passage of microwave radio frequencies for guidance of a missile, and protects the internal guidance equipment from its operating environment.

In missile applications, the radome must withstand high temperatures and thermal shock; sudden aerodynamic pressures; vibration and destructive erosion by raindrops moving at enormous relative velocity.

A new and versatile family of materials, glass ceramics, has now emerged to do this vital job.

While it is protecting internal guidance instruments from this hostile environment, a radome must maintain stable dielectric characteristics for continuous, accurate guidance.

In addition to these two major requirements, the ideal radome must meet the need for minimum weight and reasonable cost, and be reproducible on a mass production scale.

Currently, three different materials are available for radome applications. They are alumina ceramics, fiber glass laminates and, recently developed, glass-ceramic crystalline materials known as Pyroceram.

Pyroceram is an entire family of new materials, perhaps as numerous and varied as glass itself. Although not developed specifically to meet radome requirements, it has been used first in that application.

• **Development**—The chain of events that led to the development of Pyroceram can be traced back to 1938. Dr. Robert H. Dalton, a Corning Glass Works chemist, produced a deeper color in ruby-hued glass by irradiating it with ultraviolet, then heat-treating it. This discovery made it possible to produce controlled patterns of color in glass by selecting the areas exposed to ultraviolet.

The investigation was taken up three years later by Dr. S. Donald Stookey, a young chemist who had just joined Corning's research organization. Searching for a way to produce opal white images in glass, he studied the effects produced by ultraviolet.

This study led to the development of a true photosensitive glass, in which white, three-dimensional images could be reproduced precisely in the glass. Ultraviolet radiation acted as the sensitizing agent, and double heat treatment developed the image. But, unlike ordinary photographic printing, the image was reproduced not only on the surface but in and of the glass itself.

Dr. Stookey soon found that the white portions of the new glasses differed in several respects from the untreated glass. He experimented with acids and found that the white image dissolved much more quickly than the adjacent clear glass.

This fotoform process, in effect, produced a basic new material, with thousands of new applications for glass that could be chemically machined with precision. For example, in fine mesh screens for electronic tubes, the process creates wafers of glass with as many as 560,000 evenly spaced holes per square inch.

During a test of the new material, a plate of fotoform glass was left in a laboratory furnace with a faulty heat controller. The heat inside rose more than 600 degrees F. above the level for which it was set. When the test plate had turned a dark brown, it was as solid as before. Investigation showed that the overheated piece of fotoform had undergone a basic physical transformation.

• **Structural change**—Unlike most substances, the basic structure of glass

does not change from a liquid to a solid at any fixed temperature. It retains the characteristics of a liquid made of fused, inorganic materials. Because of this fundamental behavior, true glass is noncrystalline.

In the overheated test plate, it was found that the basic structure had been changed from noncrystalline glass into a crystalline, ceramic-like material. It possessed unusual electrical properties, was harder and three times stronger than the parent glass and had a higher softening temperature. The new material was named Fotoceram.

The discovery of Fotoceram took place in 1953. At that time, Corning's research laboratory was involved in a radome material testing program with the Applied Physics Laboratory of Johns Hopkins University. Some of Corning's glass samples performed well under tests for electrical and thermal properties, but rain erosion tests presented an obstacle. Shortly after Fotoceram was developed, and before complete data on properties was available, samples of the new material were submitted to APL.

While the tests were underway, the exploration of the unusual characteristics of Fotoceram was continued. It was realized that there would be a great advantage in bypassing the photosensitive process and producing the crystalline material by a more direct method. Since heating schedules affected the size and density of the tiny crystallites in Fotoceram, an effort to trigger crystal growth by heat alone was undertaken.

• **New material**—In less than three months the attempt was successful. Special chemicals added to the glass batch acted as seeds for crystal growth, and it was soon possible to produce glass-ceramic materials directly from glass through a careful schedule of heat treatments. The substances were melted, formed and cooled like a glass, then transformed into the crystalline material by heat.

As the new compositions were melted and tested, it was found that the glass-ceramics—now called Pyroceram—could be made as hard as high-carbon steel, several times stronger than the parent glass, and could be heated to 1300 F, then plunged into ice water without breaking. Some types could withstand temperatures above 1,800 F without deformation.

It was also found that Pyroceram could be made an opaque white or a transparent material. Because it is first a glass, the new substance can be formed into any shape that can be



IMMEDIATELY AFTER forming, the glass radome is placed in annealing kiln. This removes stresses before machining.

achieved with glass, using the same glass forming processes—blowing, pressing, drawing, centrifugal casting. Some types can even be cast like metals.

Because the properties of Pyroceram could be tailored for particular electrical, thermal and hardness requirements, samples were sent to APL. The samples tested out so well that negotiations for radome development contract for the *Terrier* surface-to-air missile were prepared before the radomes had even reached the pilot plant evaluation stage.

Perhaps the most serious problem at the beginning of the development program was a lack of broad technical data about the material on which production designs could be based. When the contract was signed, little was known about the operating properties or its melting and forming characteristics. Moving any new glass from laboratory crucible melting to pilot plant tank melting is a lengthy and complex process.

• **Forming**—One of Corning's research-developed processes solved the need for high-speed, close-tolerance forming. It was the centrifugal casting machine, called the spinner, developed in 1949 for forming the funnel of glass television bulbs. The spinner was ideally suited to forming the radome shape.

Manufacture of truly homogenous, bubble-free glass required for optical glassware had been restricted to small batch melts. In 1945, a method was developed for producing flawless glass continuously from a mass production glass tank. This process permits production of glass radome blanks free of imperfections.

One of the difficulties presented by the new material was the need to melt it at high temperatures. In the delivery end of the melting tank, it had to be held at temperatures well above the normal range for glasses. Because of this greater heat, and a lower viscosity than most glasses, the material was extremely fluid at the forming stage. Cooling had to be carefully controlled to prevent runaway crystal growth.

The melting problems were solved through adaptation of the processes developed by the company for high-temperatures and rates of delivery and cooling. This was correlated with control of viscosity of the molten material.

• **Grinding**—Because of the necessity for precise electrical characteristics, the wall thickness of a radome must be held to very close tolerances. This requirement is one of the most difficult obstacles faced by a radome manufacturer, whether his material is fiber glass laminate, alumina ceramic, or Pyroceram.

The spinner machine formed glass to tolerances close enough for most requirements, but the precision finish needed in radomes was on another order of magnitude. It was apparent that the glass-ceramic radomes would have to be machined.

Members of the machine research department at Corning conceived a unique approach to the problem. Using a grinding method probably never before applied to radomes, they tested their theory on small sample cones. The technique achieved tolerances as close as .001 of an inch on wall thickness. Full-scale equipment was designed and built for the prototype radomes.

Even with the new equipment, finishing the radomes was a major operation. The ogive shape proved considerably more difficult to grind than the cone-shaped samples, and the very hardness that gave Pyroceram good radome characteristics made it resistant to machining. Actual tests showed it took about four times as long to remove a sixteenth of an inch from Pyroceram than from glass.

One of the solutions to these difficulties was simply to grind the radome in its glassy state, before it had been ceramed into crystalline material. As a glass, it was considerably easier to finish, and as forming techniques were perfected, it became possible to grind closely enough in the glassy state so that only touch-up finishing was required in the final material.

Later improvements in equipment speeded the finishing action and reduced total grinding time to a fraction of its earlier duration.

• **Production**—To illustrate the volume production potential of Pyroceramic radome, it might be well to briefly review the steps involved.

The Batch: Ingredients for the glass

Servo Motors For

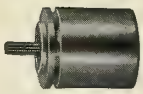
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• Meets MIL-E-5272 • −65°C to +125°C temperature range.

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	SIZE 8	SIZE 10	SIZE 11	SIZE 15	SIZE 18
Oster Type	8-5001-00	10-5052-00	11-5101-00	15-5153-00	18-5201-00
Electrical Characteristics:					
Frequency (cps)	400	400	400	400	400
Torque at Stall (oz. in.)	.15	.30	.63	1.45	2.35
No Load Speed (rpm)	6500	6500	6500	5200	5200
Speed at Half Torque (rpm)	4000	4000	4000	3200	3200
Time Constant (sec.)	0.03	0.015	0.016	0.017	0.013
Reversing Time (sec.)	0.051	0.025	0.028	0.030	0.022
Theo. Acceleration at Stall (rad/sec²)	22500	45000	41500	31000	40000
Operating Temp. Range (°C.)	−54 to +125	−54 to +125	−54 to +125	−54 to +125	−54 to +125
Slot Effect	1.6v/26v	1.0v/36v	1.0v/40v	1.0v/40v	1.0v/40v
Duty Cycle	Cont.	Cont.	Cont.	Cont.	Cont.
Fixed Phase					
Voltage	26	115	115	115	115
R (Stall) Ohms	196	1270	1250	490	280
X (Stall) Ohms	183	1560	1780	890	570
Z (Stall) Ohms	268	2210	2175	1030	640
P.F. (Stall)	0.73	0.57	0.58	0.49	0.45
Effective R (Stall) Ohms	366	3840	3800	2160	1460
Parallel Tuning cond. for unity P.F. (Stall) Mfd.	1.0	0.13	0.15	0.33	0.55
Control Phase					
Voltage	40/20	40/20	40/20	40/20	40/20
*R (Stall) Ohms	480	124	145	58	39
*X (Stall) Ohms	445	215	204	103	77
*Z (Stall) Ohms	660	248	250	118	86
*P.F. (Stall)	0.73	0.50	0.58	0.49	0.45
*Effective R (Stall) Ohms	910	495	430	240	190
*Parallel Tuning cond. for unity P.F. (Stall) Mfd.	0.4	1.4	1.3	2.9	4.1
Mechanical Characteristics:					
Rotor Inertia (gm. cm²)	.47	.47	1.07	3.3	4.0
Weight (oz.)	1.2	2	4.5	8	14
Mounting Type	Synchro	Synchro	Synchro	Synchro	Synchro
Motor Length	.863	.672	1.703	1.625	2.03
Type Shaft	Pinion	Pinion	Plain	Plain	Plain
Shaft Extension	.375	.218	.437	.540	.540
Outside Diameter	.750	.937	1.062	1.437	1.750
Type Connection	Leads	Terminals	Terminals	Terminals	Terminals

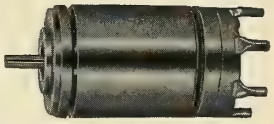
*For 40v connection



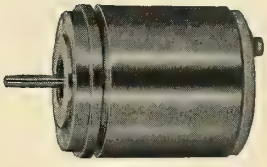
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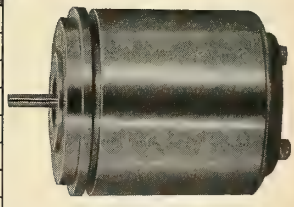
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BLOWTORCH demonstration of the heat resistance of a glass-ceramic radome.

batch are selected for purity by chemical analysis. The raw materials are carefully weighed and proportioned to assure the uniformity of the parent glass, and ultimately of the crystalline product. Thoroughly blended in huge mizers, the batch materials are fed into the melting tank at a carefully controlled rate.

Melting: Melting the parent glass is done in a continuous glass tank. Specially compounded refractory lingings are used to minimize contamination of the molten glass, assuring chemical purity. In the pre-melt section of the tank, heat reduces the batch to viscous liquid. Then it flows into a fining chamber where bubbles are removed from the molten glass. Finally, the glass flows into forehearth or delivery end of the tank.

Forming: The glass is delivered in predetermined amounts from the tank into a steel female mold. Then the radome is formed in seconds by spinning the mold at high speed, creating centrifugal force which spreads the glass upward against the inside surface of the mold.

Annealing: The glass cools rapidly during the forming operation. The radome blank can be taken immediately from the mold and transferred to an annealing oven, where internal stresses caused by the sudden cooling are removed by temperature cycling.

Preliminary Inspection: The radome blank is removed from the annealing oven and inspected visually. The material is transparent in its glassy state and internal defects are easily detected. Faulty blanks are rejected.

Preliminary Machining: The inspected blank is taken to the finishing facility where it is rough ground to required dimensions. At this stage, the inside surface is contour ground to the approximate size required, and any excessive stock on the external surface is also removed.

Ceraming: The semi-machined radome blank is placed in a ceraming kiln and heat treated in accordance with a carefully prescribed schedule. During the heat treatment, nucleating agents in the glass cause a controlled crystallization of the material, transforming it from glass into the opaque white state.

Final Machining: The ceramed radome blank is returned to the grinding department for final finishing. During this final grinding, the inside surface is touched up and finish-ground to the prescribed internal contour. Since dimensional changes are minor in the conversion to the crystalline phase from glass, extensive grinding is not necessary. Finally, the outside of the radome is ground to contour and specified wall thickness, finishing to the required length.

Mounting: Last step in the preparation of the radome is to join it to metal ring which can be bolted, revited, or attached by latch couplings to the body of the missile. The base of the radome is permanently bonded to the metal ring with a suitable adhesive. The mounting ring acts as a graded seal between the frangible radome and the ductile metal body, and normally matches the expansion coefficient of the radome. If a perfect match is not possible, a flexible joint is used in the mounting. After mounting, the radome is given a final inspection and then shipped.

• **Advantages**—Fabrication of Pyroceram radomes offers a substantial advantage over alumina or fiber glass laminates in ease and speed of manufacture. Perhaps more important, the manner in which the radomes are produced guarantees precise reproducibility of properties from one radome to another. After being machined to specified dimensions, the glass-ceramic radomes are alike in every respect, including electrical properties.

• **Properties**—The glass-ceramic radome has extremely dielectric properties over a broad temperature range. For example, at a frequency of 10^{10} cps., dielectric constant is 5.45 at 77 degrees F, 5.51 at 572 F, and 5.53 at 932 F. Over the same temperature range, dissipation factor goes from 0.00033 to 0.00075 to 0.00152. These electrical properties remain almost unchanged up to the material's top operating temperature of 1,800 F.

The radomes will withstand 2,200 degrees F. for short terms without deforming, and its thermal expansion coefficient of 32 x 10^{-7} per degree F gives it excellent resistance to thermal shock.

Thermal emissivity is also high. At an altitude of 100,000 feet, and a speed of Mach 6, the glass-ceramic will have a mean temperature of 1300 F; while under the same conditions alumina will be operating at 1800 F. The variance is broader at higher speeds, cancelling most of the 900° advantage of alumina's higher deformation temperature. Pyroceram radomes can also stand thermal gradients nearly 50% greater than the limit for high alumina.

The mechanical properties of Pyroceram fall well within radome requirements. The modulus of elasticity at 77 degrees F is 17.3 x 10^6 psi, Poisson's ratio is 0.245 and flexural strength is 26,000 psi. Using the Vicker's Diamond Pyramid test at 500 grams load, hardness is 618. Using a specific gravity of 2.60 at 77 degrees, it falls between the two other radome materials for weight. Although glass-ceramic flexural strength is lower, a strength-to-weight comparison between alumina and glass-ceramic radomes favors Pyroceram.

• **Future uses**—It is obvious that applications of the new glass-ceramics will not be restricted to radomes. Potential uses in missiles and aircraft may include skin panels, leading edges.

Some of these applications will hinge on the fundamental research at Corning that is still broadening the range of compositions and properties that can be achieved with the glass-ceramics. Higher temperature melting facilities are being prepared for the development of glass-ceramic materials that may extend the operating limits well above the present temperature range. Work on physical properties makes flexural strengths of 100,000 psi a foreseeable achievement, and crystal-clear, high-strength materials are already being developed.★

High Energy Liquid Fuels Promising

But extensive hardware testing is needed for boranes, which are in short supply

By Donald E. Perry

High-energy fuels hold great promise for the missile industry. But they are in short supply and their properties not yet well defined.

Many of the fuels, particularly the boranes, will have to await extensive hardware development programs.

This is the opinion expressed by one researcher for a major petroleum industry. Robert A. Wells, staff engineer, Gulf Oil Research Center, said that "Actually, more can be done by improving oxidizers than the fuels."

The nation's much publicized high-energy fuel program started with the Navy's project "Zip" in 1952, which the Air Force joined in 1955. This multi-million dollar program, based on diborane, resulted in a major fuel technology breakthrough. A new series of boron-carbon-hydrogen compounds were developed that retain much of the high energy of the boranes but are more stable, less toxic and of higher density.

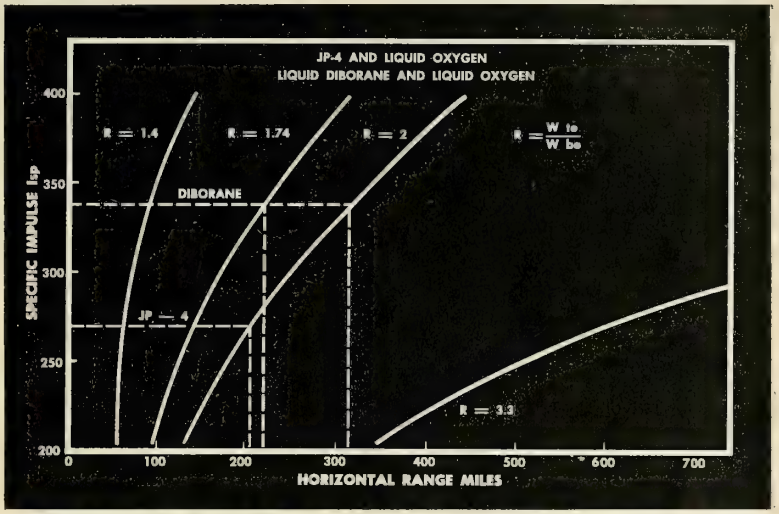
Olin-Mathieson Chemical Corp. has completed and started operation of a production plant to produce boron fuels for solid propellant rockets. Callery Chemical Co., of which Gulf is 25% owner, also is in the boron picture (see m/r April, 1958, p. 85). Both plants are multi-million dollar ventures.

• **Much to be done**—With boron fuels now in production, although probably limited, Wells' statement is particularly significant. While much literature today quotes current I_{sp} as 250, based on a chamber pressure of 300 psi, Wells concludes that a more realistic value for present ICBM-type rockets would be in the 500-600 psi range.

He considers high-energy fuels for rockets as those having theoretical I_{sp} ratings above the 272 rating of JP-4 and liquid oxygen at 600 psi chamber pressure. While security does not permit giving the specific properties of the several HEF (high-energy) fuels, Wells did compare available information on several boron hydrides which closely resemble these boron-carbon-hydrogen fuels. Essentially, the fuels differ from the boranes by the substitution of alkyl groups for some of the hydrogen. The engineer believes that the Air Force's HEF-3 is ethyl alkylated decaborane, a liquid, although decaborane is a solid.

"The smallest alkyl group practical is probably desired in order to substitute as little carbon as possible for some of the hydrogen and prevent drastic reductions in the heat content from the basic boranes," Wells adds.

Boron hydrides have been extensively investigated in small and full-size burners at NACA's Lewis Propulsion Laboratory. The Btu-lb rating of these fuels, along with a performance rating



RANGE PERFORMANCE of a hypothetical rocket vehicle with JP-4 and liquid diborane compared. Diborane would require larger tank.

COMPARING PERFORMANCE OF BORON HYDRIDES

	Form	A Btu/lb.	B Density	A x B	A x B (for JP-4)	State
Hydrogen	H_2	51,500	.000089	5	.00004	Gas
Beryllium	Be	29,100	1.8	52,500	3.64	Solid
Boron	B	25,400	2.0	50,000	3.47	Solid
Diborane	B_2H_6	31,300	.0012	36	.00025	Gas
		31,100	.46 (–92.4°C.)	14,300	.99	Liquid
Pentaborane	B_5H_9	29,100	.631	18,300	1.27	Liquid
Decaborane	$B_{10}H_{14}$	27,900	.94	26,200	1.82	Solid
		28,200	.72	20,300	1.41	Liquid
Alkylborane	B-C-H	25,000	.82 (13)	21,600±	1.5	Liquid
Jet Fuel	JP-4	18,700	.77	14,400	1.00	Liquid
Rocket Fuel	RP-1	18,580	.81	15,100	1.05	Liquid
Jet Fuel	JP-6	18,447	.80	14,800	1.03	Liquid

—a product of their Btu/lb multiplied by their density, divided by the same product for JP-4—is shown in the accompanying table.

• **Hydrocarbons still important**—Wells points out that HE fuels, even with a fuel production price of $1 per pound, will be 50 times more expensive than hydrocarbon fuels. One notable feature, however, is that modification of the boranes into HEF has apparently reduced vapor pressure. This, in turn, has reduced the likelihood of explosive or toxic vapor concentration. One fuel producer has reported an accident level substantially lower than the chemical industry average.

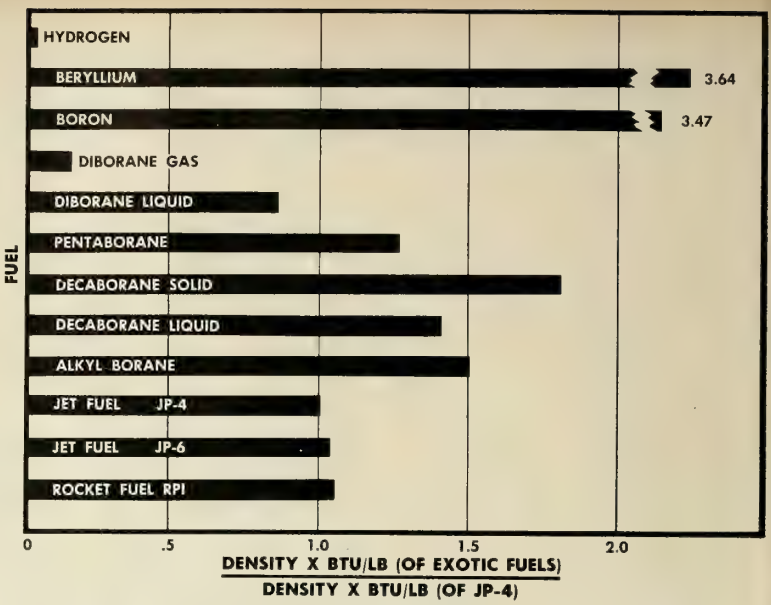
Meanwhile, hydrocarbon fuels are part of the propellants in many rockets now being designed, produced fired to obtain development data. Much effort is being made to improve their reliability and accuracy by more closely defining the characteristics of hydrocarbon fuels, and refining the definitions still further by considering specific hydrocarbon chemicals.

RP-1 fuel, JP-6H and the alkylated polycyclic materials evolved from this type of approach. I_{sp} for these fuels in rocket engines would show good values due to the low molecular weight of the exhaust gases, as compared to nonhydrocarbon fuels, according to Wells. Of interest is that these hydrocarbons can be made available from coal tar distillation at a presumably reasonable price, but the price could be greater than hydrocarbons from petroleum.

• **Trouble in specs**—One of the problems inherent in extension of the present types of specifications to include chemicals for rockets is the specification requirements themselves, Wells said. Fuels derived from petroleum have always been used for aircraft, and specifications have been written to include items such as distillation range, smoke point, aniline point, etc.

But in at least one area something is being done. A modified RP-1 fuel specification is now being written which will attempt to define properties in terms of qualities known to be critical to rocket engine performance. These items may include density/temperature relationship; viscosity/temperature relationships; vapor pressure; C:H ratio/ and heat of combustion. Additional requirements probably will attempt to insure against corrosion, contamination, storage and thermal instability.

• **Comparison**—Wells has compared JP-4 and liquid diborane for a hypothetical rocket vehicle with fixed hardware. The only variables considered are the changes in I_{sp} and W_{to} (weight on takeoff) due to the density of liquid diborane at 0.46 as compared to JP-4 at 0.77.



CHARACTERISTICS of the borane fuels show that low density of diborane adversely affects its mass ratio and offsets the theoretical increase in I_{sp}.

Diborane is combustible over a wider fuel/oxidizer range than are hydrocarbons, so the rocket fuel tank is filled for the same weight as JP-4 with the same number of gallons for the comparison.

Conclusion is that the low density of diborane adversely affects its mass ratio and offsets the theoretical increase in I_{sp} when these values are applied to rocket range and velocity at burnout. Wells parameter predicts that there will be no significant difference in performance between JP-4 and liquid diborane.

According to Wells,

"If we assume $\frac{W_{to}}{W_{bo}} = 2$ for our rocket with JP-4, and JP-4 = 32% by wt. of total propellant, then the diborane fueled rocket would have a

$$\Delta W_{to} = 2 \left[.68 + .32 \times \frac{\text{Density of Diborane}}{\text{Density of JP-4}} \right]$$

$$\Delta W_{to} = 2 \left[.68 + .32 \left(\frac{.46}{.77} \right) \right]$$

$$\frac{W_{to}}{W_{bo}} = 1.74$$

"This calculation indicates that, for a single stage rocket of given configuration, the velocity at burnout would be the same for both JP-4 and liquid diborane in LOX. But, if the hardware could be adjusted to keep the same mass ratio of 2 for the liquid diborane, then the velocity would be increased by 26%.

"The same process, using the range formula, results in an increase of 20% with liquid diborane in a fixed hypothetical vehicle, compared with an increase of 57% where the hardware was designed to a mass ratio of 2.

"Diborane is probably not being considered for such applications due to this low density. The molecular weight of combustion gases affects the values of I_{sp} as do the temperatures of the gases. The heavy exhaust products from the alkyl borane fuels, which reduces theoretical I_{sp}, coupled with the high-flame temperatures—which increase theoretical I_{sp} but may destroy hardware—pose additional problems for the rocket designer.

"Liquid alkylated decaborane fuels have much higher density although their I_{sp} may be appreciably lower. The value of alkyl borane fuels in liquid propellant rockets must await an extensive hardware evaluation program."

Pyrophoric fuels (liquids which ignite spontaneously in air), if used in concentrations of 15 to 30%, can improve burning and reduce screech in rockets. According to Wells, this gives more reliable operation at higher altitudes and leaner fuel/air ratios.

These fuels now available for testing are organo-metallic compounds. Three materials have been prominent in this field—TEA (triethyl aluminum), TEB (triethyl borane), and TMA (trimethyl aluminum). Recently a new material, TNN (tributyl borane), has been synthesized which has very high flame speeds and blow-out velocity. It has the unusual safety feature in that it does not burn when exposed to air, but must be sprayed before it exhibits its pyrophoric characteristics.★



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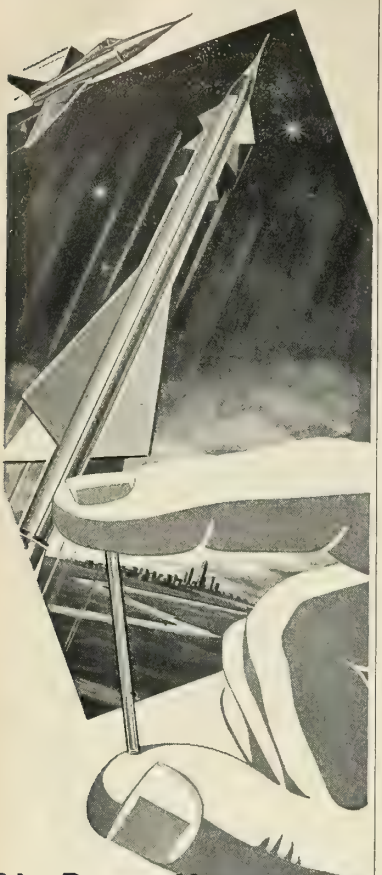
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space age



by Norman L. Baker

Dyna-Soar—The first phase of the Air Force *Dyna-Soar* space glide-bomber development will be devoted largely to organization of the two groups of contractors, headed by Martin and Boeing, into working teams. The meager $7-million-letter-contract giving Martin and Boeing the go-ahead is expected to involve a six to eighteen month period of heated competition. During this time, the contractors will be expected to finance development and organizational expenses from their own capital. It is further expected that only one team will be awarded the much sought-after production contract.

The major subcontractors in the Boeing team are Ramo-Wooldridge Corp., General Electric of Syracuse, N.Y.; North American's Autonetics and Missile Development divisions; Aerojet-General; and Chance Vought. In the Martin team are Bell Aircraft, Goodyear, American Machine and Foundry, Bendix and Minneapolis-Honeywell.

The Martin team will draw heavily on Bell's pioneering work on the *Bomi* boost-glide bomber project. Although it has been reported the *Dyna-Soar* vehicle will be designed as an entirely new system, both teams will rely heavily on the *Navaho, Titan,* and X-15 development programs. Bell, North American and Boeing have spent several years studying the boost-glide bomber concept.

The last stage of the *Dyna-Soar* system, if based upon previous Bell and Boeing studies, will be a delta-wing vehicle with one to three liquid rocket engines as sustainer power plants. Undersurface of the bomber will be flat for more positive control of attitude during re-entry and dissipation of the high heat of aerodynamic friction.

The Dyna-Soar vehicle, essentially a short duration satellite, if in the ten to fifteen-ton gross weight category, will require a first stage propulsion system developing approximately one-million pounds of thrust. Unless propulsion systems now in development are clustered to achieve the one-million figure, the final development of *Dyna-Soar* may be at least five years away.

Dr. Herbert York, chief scientist of ARPA, estimates that it will take five years before the one-million pound engine will be flying and several more years of flight testing. DOD released $450,000 for the project in 1958, with an additional $15-million slated to come out of 1959 funds.

The *Vanguard* **program,** with five remaining vehicles for 20-in. satellite launch attempts, will receive an additional $9.8-million for fiscal 1959. SLV-2, the third failure to launch the full size satellites, was instrumented for further investigation of the radiation belt discovered by *Explorer* III. The *Explorer* program, with a $3.5-million budget for 1958, has no programmed obligations for 1959.

when and where

JULY

Computers and Data Processing Fifth Annual Symposium, Albany Hotel, Denver, Colo., July 24-25.

Society of Photographic Instrumentation Engineers, Third Annual Exhiborama, Second Annual Symposium, Statler Hotel, Los Angeles, Calif., July 29-31.

AUGUST

ARS, IAS, Regional Technical Meeting, "Space Exploration", San Diego, Calif., Aug. 5-6.

AIEE, IRE, NBS, Conference on Electronic Standards and Measurements, National Bureau of Standards Boulder Laboratories, Boulder, Colo., Aug. 13-15.

Missiles Operations Research, Engineering Seminar, Pennsylvania State University, University Park, Pa., Aug. 17-23.

AAS Annual Western Regional Meeting, Stanford University, Dinkelspeil Auditorium, Palo Alto, Calif., Aug. 18-19.

ASME, A. I. Ch. E. Conference, Northwestern University, Evanston, Ill., Aug. 18-21.

Western Electronic Show & Convention, Institute of Radio Engineers, Ambassador Hotel, Los Angeles, Calif., Aug. 19-22.

Ninth Annual Congress, International Astronautical Federation, Amsterdam, Holland, Aug. 25-30.

SEPTEMBER

First International Congress of the Aeronautical Sciences, Palace Hotel, Madrid, Spain, Sept. 8-13.

American Rocket Society, Fall Meeting, Hotel Statler, N.Y., N.Y., Sept. 14-18.

Professional Group on Telemetry and Remote Control, 1958 meeting, Americana Hotel, Bal Harbor, Miami Beach, Fla., Sept. 22-24.

Air Force Association, Airpower Showcase, Dallas, Texas, Sept. 25-27.

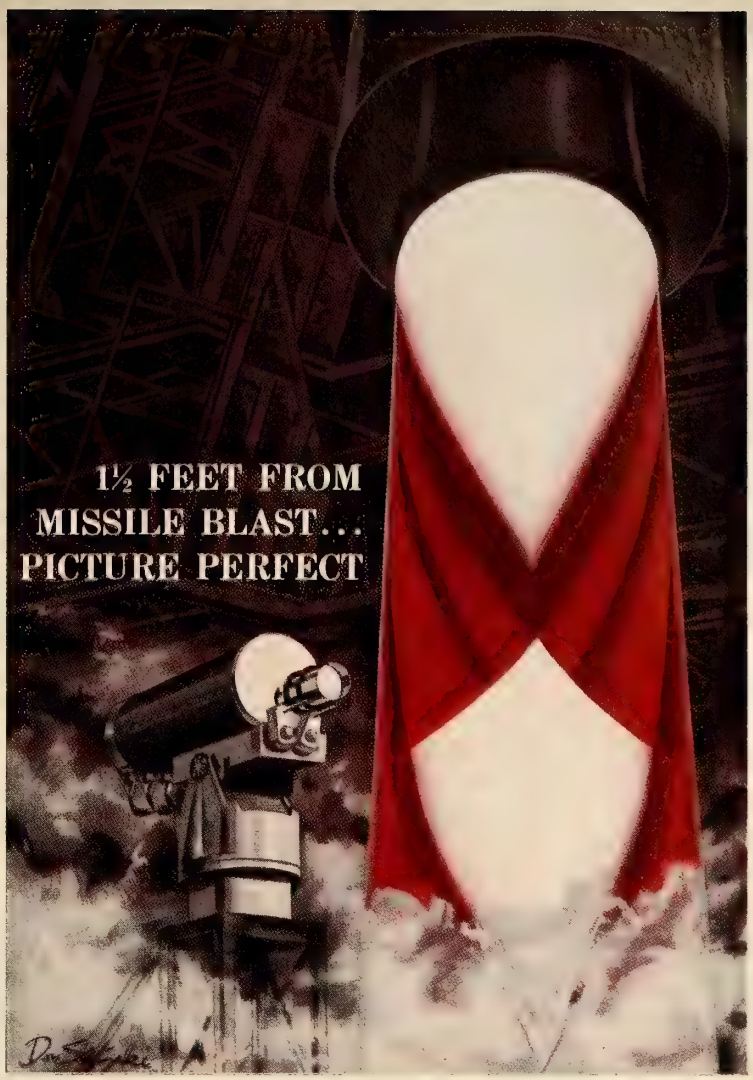
ASME Power Conference, Statler Hotel, Boston, Mass., Sept. 28-Oct. 1.

National Aeronautic Meeting, Society of Automotive Engineers, Inc., The Ambassador, Los Angeles, Calif., Sept. 29-Oct. 3.

OCTOBER

Association of the United States Army 1958 annual meeting, Sheraton-Park Hotel, Washington, D.C., Oct. 20-22.

Institute of Radio Engineers East Coast Conference, Aeronautical & Navigational Electronics, Lord Baltimore Hotel, Baltimore, Md., Oct. 27-28.

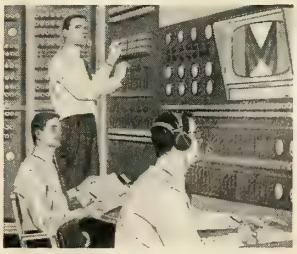


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With white noise environment beyond 150 db., Hallamore 100% remotely controlled, "ruggedized," transistorized cameras provide close-up observation at our nation's major missile installations. Combined in complete Hallamore closed circuit TV systems, they perform, under conditions impossible for other equipment, at both the industrial and the military level. If you have a visual communication requirement, conventional or with environmental conditions involving high acoustic levels and extreme shock, contact Hallamore CCTV Dept. 8352 Brookhurst Avenue, Anaheim, Calif./TWX: AH 9079.

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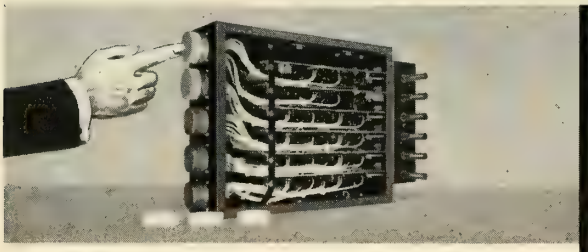
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ELECTRO-MECHANICAL CONTROLS, SWITCHES and OTHER COMPONENTS FOR MISSILE-TYPE APPLICATIONS

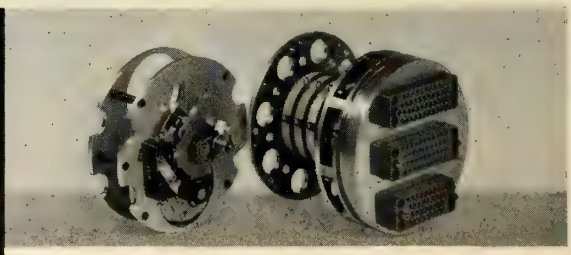
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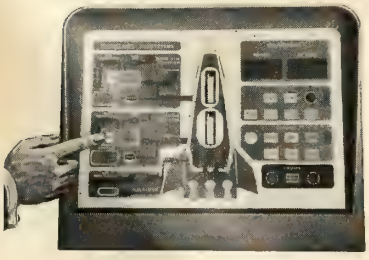


Emergency Fire Control—Used in the Flight Engineer's console of the Douglas Globemaster, plunger actuation allows instant emergency operation of any or several of the following: prop feathering, closing cowl and oil cooler doors, stop fuel and electrical service, fire extinguishing system actuation. Unit illustrated handles six distinct areas with instant cancellation of command feature for error correction.



Ground Power Changeover Control—This assembly (airborne) provides remote control of the transfer from external to internal bird power. Of compact and efficient design, its multiple-contact circuit breaking design allows more than 2 amp and 500 VDC capacity with ample margin. Partial assembly only, shown.

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Regardless of the complexity of your control problems, "MCG" will give you dependable results that can save you time and money.

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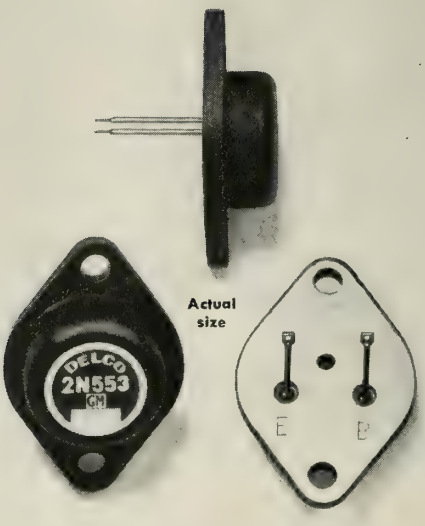
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ANNOUNCING...

the newest addition to the Delco family of PNP germanium transistors! It's ideally suited for high-speed switching circuits and should find wide use in regulated power supplies, square wave oscillators, servo amplifiers, and core-driver circuits of high-speed computers. It's the 2N553!

NEW HIGH-FREQUENCY POWER TRANSISTOR BY DELCO

No other transistor offers so desirable a combination of characteristics for applications requiring reliability and consistency of parameters.

TYPICAL CHARACTERISTICS T = 25°C unless otherwise specified

Collector diode voltage V_{CB} (V_{EB} = −1.5 volts)	80 volts maximum
Emitter diode voltage V_{EB} (V_{CB} = −1.5 volts)	40 volts maximum
Collector current	4 amps. maximum
Base Current	1 amp. maximum
Maximum junction temperature	95°C
Minimum junction temperature	−65°C
Collector diode current I_{CO} (V_{CB} = 2 volts)	12 μa
Collector diode current I_{CO} (V_{CB} = −60 volts)	0.5 ma
Collector diode current I_{CO} (V_{CB} = −30 volts, 75°C)	0.5 ma
Current gain (V_{CE} = −2 volts, I_C = 0.5 amp.)	55
Current gain (V_{CE} = 2 volts, I_C = 2 amps.)	25
Saturation voltage V_{EC} (I_B = 220 ma, I_C = 3 amps.)	0.3
Common emitter current amplification cutoff frequency (I_C = 2 amps. V_{EC} = 12 volts)	25 kc
Thermal resistance (junction to mounting base)	1° C/watt

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726 Santa Monica Boulevard
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DELCO RADIO Division of General Motors
Kokomo, Indiana

Circle No. 18 on Subscriber Service Card.



west coast industry

by Fred S. Hunter

Pop-up-pops—Reports from the San Clemente Sea Test Range indicate that the Navy's "pop-up" system for launching the *Polaris* IRBM for submerged submarines is working out all to the good. The missile is launched from vertical tubes by compressed air or gas. But the real test will come when they light the fuse. No hint yet how soon this may take place.

Ground handling—Launchers for the *Nike Hercules* possess the dual capability of firing both the old *Nike Ajax* and its atomic-capable successor. The *Hercules* missile structure, four times larger than the *Ajax,* was required to fit into existing elevators and storage areas at established *Ajax* launching sites.

This imposed severe design limitations, which were solved jointly by Douglas Aircraft Co. and Consolidated Western Steel division of U.S. Steel Corp. The Army is installing the initial *Hercules* launchers at permanent locations near metropolitan areas. However, the missiles are also designed as field weapons, thus the equipment can be quickly disassembled for removal to a new site.

Skin divers—Aerojet-General's underwater engine division is working hard these days. It is testing a high-speed propulsion system, described as radically new in design, in the ring channel at Azusa. (This is where feasibility of underwater launch of the *Polaris* was proved). A free-running test missile has been developed, which was fired with accuracies approaching those of aircraft rockets.

Aerojet is now working on a $36,320 R & D contract from the Federal Maritime Board to explore the feasibility of a submerged cargo ship to be driven at high speeds by water-jet propulsion.

Computer pilots—From W. J. Cecka, Jr., Rocketdyne's test manager, comes news that mathematicians at North American's rocket engine division have worked out a trip to Mars on computers, using ion rocket engines. The trip totaled 46.6 million miles, and required 323 days. That's a speed of about 6,000 mph. Cecka says that had the computer jockeys been a little more certain of their course, three weeks might have been clipped off the trip's time.

New test site?—Appearance of numerous automobiles carrying Jet Propulsion Laboratory identification at Camp Irwin has led to speculation that the Army plans to use the big tank training ground northeast of Barstow for rocket research and development—and possibly some space work. That's wide-open country!

High style—Latest thing in computers and data processing devices seems to be gay color schemes. One manufacturer offers five or six different hues. Reason is that expensive data rooms, we're told, cost something over $18 per square foot. This shouldn't be cheapened by plain old black or gray boxes!

Locate Leaks The Easy Way

With General Electric's new and complete line of leak detectors

G.E.'s versatile, Type H halogen leak detectors locate leaks quickly and accurately in any system or component under pressure or vacuum. They are easier to use and much more sensitive than ordinary methods of leak detection.



(A) Standard control unit is used with any one of the following detectors: (B) gun detector, (C) stationary detector, (D) vacuum detector, (E) pencil-probe detector.

For more information write for Leak Detector Bulletin GEA-6817. Section 585-67, General Electric Company, Schenectady, N. Y.

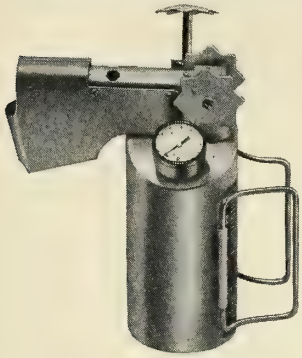
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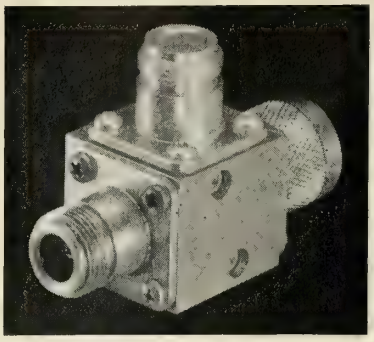
MH-162 "Hunter Space and Personnel Heaters"

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HEATING AND REFRIGERATION SYSTEMS

Circle No. 19 on Subscriber Service Card.

new missile products

Diplexer by Microphase Isolates S-Band



A diplexer designed to isolate the S-band from the X-band has been introduced by Microphase Corp. In the S-band, the insertion loss is less than 1.0 db, while in the X-band it is under 1.5 db. The isolation is a minimum of 30 db.

The filter weighs 4½ oz. and is constructed to meet rigid environmental conditions. On special request, 60 db isolation between bands is available with detracting from pass-band performance.

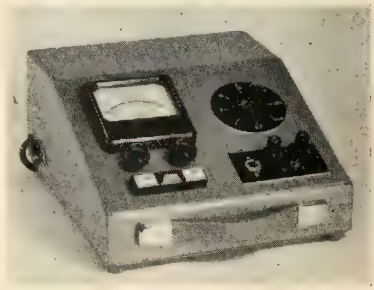
Although the filter has a 500 mc buffer zone, this can be reduced if necessary.

Circle No. 225 on Subscriber Service Card.

Interval Meter Has 2% Accuracy

Presin Co. has developed a short-time interval meter, model KM-1, with a measuring range in eight steps from 5 microseconds to 1 second, and an accuracy within 2%.

The unit is a portable one, suitable for either field or laboratory use, and is designed for such measurements as



closing and opening times of relays, circuit breakers and snap switches.

The device is also applicable to measuring exposure times of photographic shutters, determining the velocities of levers, missiles, the duration of explosion processes, and the checking of electro-mechanical lags through a system.

Simplicity of the meter enables its use by untrained personnel. Operating from a 110 vac line, the measuring process is controlled by a gate which opens during the measuring interval, charging a capacitor. The increase in the voltage drop across this capacitor is displayed by a vacuum tube voltmeter whose face is calibrated in time divisions. Size of the unit is 5" x 10¼" x 11⅞". Total weight is 13 lbs.

Circle No. 226 on Subscriber Service Card.

Bellows Expansion Joint Handles Liquid Oxygen

Skinner Seal Division of Hydrodyne Corp. has announced the production and availability of a machined bellows expansion joint for liquid oxygen and other fuel and oxidizer systems.

The product, which may be made of a variety of metal alloys and in a wide range of sizes, utilizes a spring



seal machined on each end, permitting high pressures. The joint also permits extremely high and low temperatures—the latter to −320°F.

According to the company, both environmental tests and actual applications show that the joint, with controlled wall thicknesses, has a long fatigue life.

Circle No. 227 on Subscriber Service Card.

Ignition Primer Operates Above 100,000 Feet

Holex Inc. has added model 1029A high-altitude ignition primer to its line of explosive products. The unit is hermetically sealed and designed specifically for ignition of propellants and powders at altitudes in excess of 100,000 feet. The primer is of standard screw-in construction having a ⅜-24 class 2A thread and a 7/16" hex. It is

normally supplied with integral No. 20 leads, 4½" long.

The basic load is a metallic-oxide priming mixture which has been extensively tested at altitudes over 100,000 feet for the ignition of boron and similar-type boosters and propellants, according to Holex.

The cartridge is bridge-wired with a nominal resistance of 0.25 ohms, and will withstand the application of ½ ampere for an indefinite time without firing. When fired with a current of 5 amperes dc, the unit will ignite



in approximately 13 milliseconds. Similar units are available with shorter ignition times down to 1 millisecond or less.

The cartridge has been designed to minimize static sensitivity and will withstand 1,000 volts ac between either pin and case without ignition. The primer is also designed to withstand all environmental tests called out by MIL-E-5272A. Modifications of the unit are available with different firing times and no-fire characteristics.

Circle No. 228 on Subscriber Service Card.

Transducer Measures Conducting Fluid Pressure

A new line of variable inductance pressure transducers has been developed by Datran Electronics Division of Mid-Continent Manufacturing, Inc., to measure the pressures of conducting fluids such as salt water.

It is possible to obtain these transducers, which have inner components and connections "potted", in differential, gage or absolute ranges from 0 to 10 psi up to 0 to 3,500 psi.

Electrical output from these transducers is in variable frequency, AC or DC voltage.

Circle No. 229 on Subscriber Service Card.



reduce machining time
save critical materials
assure dependable uniformity



WRITE for bulletin describing Edgewater Rings

SECURITY pretty well sums up the reasons why ring users specify EDGEWATER. High quality means security in the application. Accurate forming to close tolerances provides security from excessive machining costs. Prompt deliveries of a wide variety of ring sections and sizes spells security from expensive delays.

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Test Stations Proud

To the Editor:

Congratulations on your special mid-April issue of m/r entitled "Missile Market Guide and Directory Edition." It will be a welcome addition and of great assistance to those engaged in all facets of rocket propulsion and missile development.

The article, "How to Do Business with the Air Force" was read with great interest; however, no mention was made of the Air Force Flight Test Center in the description of test Centers under the jurisdiction of the Air Research and Development Command. In light of the recent altitude and speed records recently achieved, and the ever-increasing amount of missile system static testing being accomplished at the Air Force Flight Test Center on the present family of IRBM and ICBM missile systems, it is felt that the Air Force Flight Test Center's important role and contribution to the Air Research and Development Command's mission was overlooked.

The personnel at the Air Force Flight Test Center, and the Directorate of Missile Captive Test in particular, are proud of their test facilities and overall contribution to the missile development programs and are of the opinion that this oversight should be brought to your attention.

Philip F. Fahey, Jr.
Deputy Chief, Missile Test Division
Air Force Flight Test Center
Edwards Air Force Base, Calif.

All Americans can be proud of the work of the Flight Test Center at Edwards and elsewhere—Ed.

Hard to place

To the Editor:

Air Force and contractor people at the Air Force Flight Test Center were thrilled by the May 1958 cover picture of Test Stand 1-A at the Rocket Engine Test Laboratory here at the Air Force Flight Test Center. But the written description of the picture on page 7 stated the test stand was located at Convair-Astronautics' Sycamore Canyon facility near San Diego.

Donald L. Dynes, Deputy Chief
Missiles Facilities Division
Director of Missile Captive Test
Edwards Air Force Base, Calif.

The test stand is one three such units that are so close in outward appearance that even Mr. Dyne's crew had to identify the number of the yellow trailer in the foreground before they could be sure the stand was the one at Edwards—Ed.

Missilonics?

To the Editor:

I greatly enjoy your fine publication, but am floored everytime I read the expression, "Missile Electronics". How about shortening this unwieldy title to "Missilonics"?

Emercon W. Case
Supervisor of Data Reduction
General Electric Flight Test Lab
Schenectady, N.Y.

We have already coined the word "astrionics"—your suggestion is duly noted—Ed.

Welcomes weekly

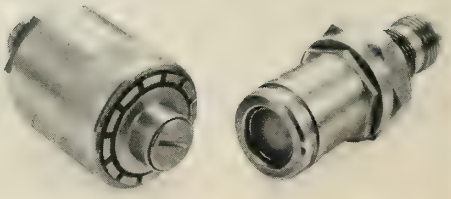
To the Editor:

I have your letter of 14 May telling of the plans to convert m/r to a weekly magazine beginning with the issue of July 7.

Please accept my congratulations.

ON MARK *Quick Disconnect Coupling*

...withstood 22,000 p.s.i. in burst test



TYPE No. 5-5002-8

In the design of this new ON MARK Hydraulic Quick Disconnect Coupling elimination of commonly used steel balls and "dogs" has avoided inherent difficulties such as Brinell type indentures in the retainer seat. This eliminates need for excessive forces at high pressure in disconnecting the coupling. Locking mechanism is smooth and positive, will compensate itself as wear occurs, which assures utmost in reliability and long life since a full 360° gripping action is used.

To connect, simply push halves of Type No. 5-5002-8 together; pull back on actuating ring to disconnect. The coupling itself or its attached hose may be gripped for connecting. Fluid loss during either operation is nil. Remotely actuated couplings are available. Coupling No. 5-5002-8 can be assembled easily, or disassembled for quick replacement of seals. End fittings may be altered to suit various applications. Complete information on request. Your inquiry is invited.

ON MARK COUPLINGS
4440 York Boulevard, Los Angeles 41, California
Telephone CLinton 4-2278

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INVITATION
to the readers of
Missiles and Rockets

This is your chance to examine FREE the first **complete** chronicle of the men and events that launched the space age: **What's Going on in Space?** by Commander David C. Holmes.

The author, a rocket and missile expert and member of the American Rocket Society, tells you the inside-Washington reaction to Sputnik . . . where the U.S. may still hold a lead in the rocket race . . . the hour-by-hour count down of Explorer I . . . the X-15 project . . . latest space-medicine discoveries . . . equipment and space-suit problems . . . upcoming manned satellites and moon shots . . . a history of rocket development since Goddard's earliest experiments. . . . PLUS other vital topics.

For your FREE examination copy of **"What's Going on in Space?"** simply mail this ad to Funk and Wagnalls, 153 East 24th St., New York 10, N. Y. Then, after ten days you may either send $3.95 plus postage or return book without obligation. **Enclose check for $3.95 now, and we'll pay postage. Refund and return privilege guaranteed.**

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I offer you my encouragement with this new venture and I sincerely hope and believe that it will prove successful. I believe that your feeling that the industry is growing so rapidly that it demands a weekly coverage of events is a sound assumption. The only way to find out "what the traffic will bear" is to seize the bull bodily by the horns. I also feel as you do that you can be of greatest service by bringing current events quickly to the attention of your subscribers.

Wernher Von Braun
Director
Development Operations Division
Redstone Arsenal, Ala.

Thank you! We will continue to grow and expand our service—Ed.

Mature Engineers Not Used?

To the Editor:

I was quite interested, and I might add amused, by the article "Top Personnel Shortage Worries Industry". (m/r, May, p. 49.)

Interested, in that I appreciate the detailed story that it tells; and amused by the one great detail that it fails to mention entirely.

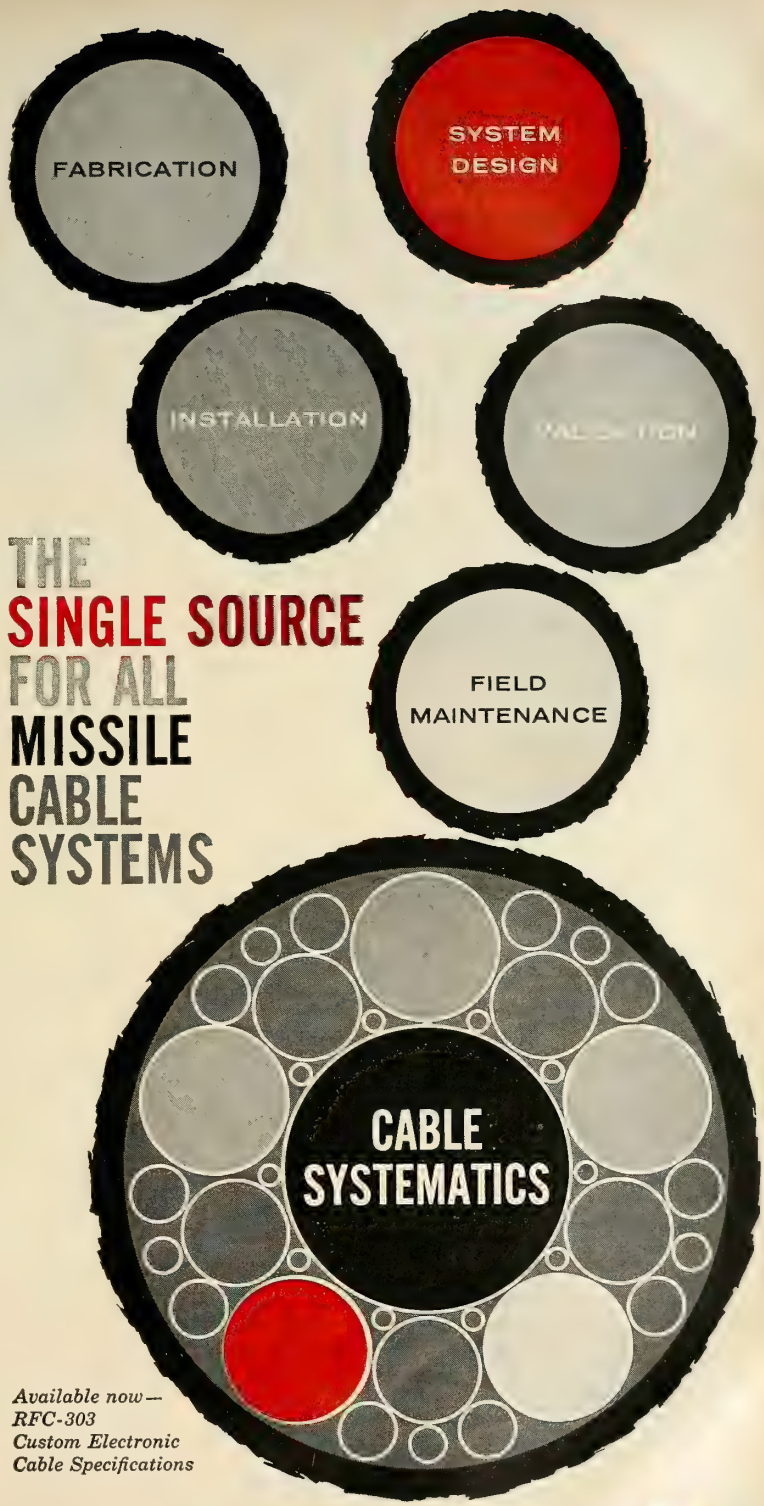
As a reputedly able and experienced mechanical-industrial engineer and a capable administrator, but of mature years, I have not been engaged in any capacity for over seven months. Many of my former friends and associates are in the same category, some for longer periods of time.

For over 25 years, many of us have been engaged in the field of precision mechanical and electro-mechanical instrumentations for government as well as industrial projects: materials and processes, component development, manufacture, and fire control systems.

Most of us agree, whole-heartedly, that there is a shortage of various types of engineering personnel. But, we cannot agree that the available engineering personnel, is and has been, utilized for the best interests of the individual or our country. The engineer, over 45 years of age and under 60 years of age, represents a wealth of experience that will take years for the younger man to acquire—and we all received our experience the hard way.

James E. Hill
1300 Steuben St.
Utica, N.Y.

We agree that there is an untapped reservoir of experienced engineering personnel that has not been properly utilized—Ed.



THE SINGLE SOURCE FOR ALL MISSILE CABLE SYSTEMS

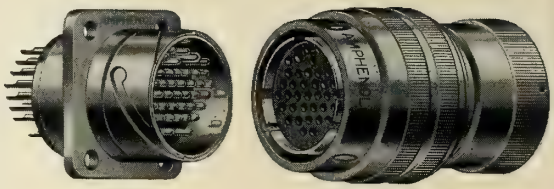
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MINNIE CONNECTORS

pass tough, new ALTITUDE-MOISTURE RESISTANCE TEST salt water immersion, 65,000 feet altitude

AMPHENOL



Designers and manufacturers of aircraft and missiles, as well as the military, have long recognized the need for a connector altitude-moisture test which would accurately simulate actual performance conditions. Such a test has been developed by manufacturers and the military and applied as standard procedure on the 67 Series *MINNIE* connectors in the AMPHENOL Laboratories. It consists of the following:

A plastic tank is filled with distilled water and salt added to obtain a solution of 1.050 specific gravity. Marker dye is added for tracing leakage paths. The connectors are given a dry insulation resistance (IR) reading with a 500 volt megohm bridge. All coupling rings are then securely hand-tightened and grommet clamps rechecked for tightness. The connectors are then completely submerged in the salt solution so that all cable bundle ends are out of the solution. The ends of the cable bundle from one side of each connector are taped. The tank and connectors are placed in an altitude chamber and another IR reading is made.

The pressure inside the chamber is then reduced to 0.82 inch of mercury (80,000 feet altitude) and held for one minute, then increased to approximately 2 inches of mercury (65,000 feet altitude). After maintaining 2 inches of mercury for ½ hour, the chamber is returned to room ambient pressure for ½ hour. This is considered one complete cycle. Connectors are subjected to a total of 10 cycles.

At the conclusion of the tenth cycle, connectors remain completely submerged in the salt solution container at room-temperature and pressure for an over-week-end soak (65 hours). Final insulation resistance reading is then taken. Immediately after last IR measurement, specific gravity of salt solution is taken.

The "E"-type construction of AMPHENOL 67 Series *MINNIE* connectors was originally designed to meet the moisture resistance requirements of MIL-C-5015C, Paragraph 4.5.21. Since the development of the new and far more stringent altitude-moisture test, *MINNIE'S* construction design has been modified and all AMPHENOL *MINNIE* "E"-type connectors pass this test.

Following the altitude-moisture resistance test, insulation resistance measurements (in megohms) on production *MINNIE* "E" connectors were as follows:

Cycle	Insulation Resistance	
	Contact to Contact	Contact to Shell
0 (Initial)	6000	7000
1	7500	4000
2	5500	3200
3	5500	3000
4 (overnight 17 hour soak)	3000	1100
5	2800	1100
6	3000	1100
7	3000	1100
8	3000	1100
9	3000	1050
10	3000	1050
11 (overnight 17 hour soak)	2800	1000
12 (weekend 65 hour soak)	3000	1050

AMPHENOL *MINNIE* "E" connectors not only meet but surpass the requirements of this tough new test. 100 megohms is the minimum insulation resistance required by MIL-C-5015C after moisture; *MINNIE'S* minimum insulation resistance after immersion and altitude cycling is 1000 megohms.

67 Series *MINNIE* "E" Connectors

DESCRIPTION Miniature, multi-contact electrical connectors of the quick-disconnect bayonet lock type. Available as Plugs, Cable and Panel Receptacles, and Single Hole Mounting Receptacles. Shell design classes include:

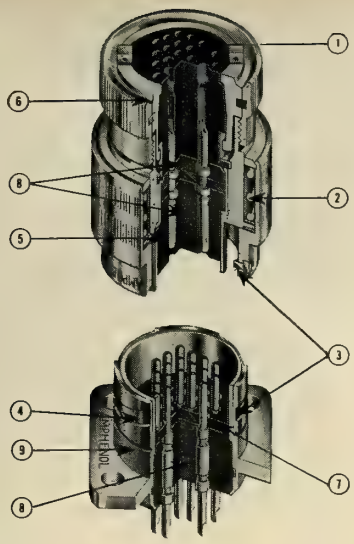
CLASS E—Environmentally resistant—individual wire seal
CLASS P—For potting
CLASS H—Hermetically sealed
CLASS J—For jacketed cable
CLASS C—Standard cable clamp

There are five shell sizes, and 17 insert arrangements—ranging from 3 contacts in the smallest to 48 contacts in the largest.

PART NUMBERING Descriptive part numbering of *MINNIE* connectors follows that used with AN (MS) connectors.

NOMINAL CURRENT RATING #20 contact is rated at 7.5 amperes and #16 contact at 17.0 amperes.

OPERATING TEMPERATURE −67°F. (−55°C.) to +257°F. (+125°C.).



HOODED SOCKET CONTACTS



Both #16 and #20 socket (female) contacts of AMPHENOL *MINNIE* connectors are resistant to test prod damage. The entering end of the socket has a one-piece hood that excludes the entrance of a pin 0.005" larger than the diameter of the mating pin. AMPHENOL Specification 340-43-2108, paragraph 4.5.14, gives this test to be used to determine resistance to test prod damage:

> *"A test prod of hardened steel having a diameter equal to a nominal mating pin shall be inserted into each socket contact to (a) .200 inch; (b) .255 inch; and (c) .310 inch depth. At each of these depths, measured from the face of the insert, a bending moment of 2 inch lbs. ±10 percent shall be applied to the 16 size contact prod and a bending moment of 0.8 inch lbs. ±10 percent shall be applied to the 20 size contact prod about the inserted ends of the prod. The connector shall be rotated in one direction through 360 degrees in order that a uniform force is applied to the inside surface of the socket contact. This test shall be performed with the socket contacts in the inserts and the contacts locked, if necessary, to prevent rotation in the inserts during the test."*

After withdrawal of the fixture at the completion of the above precedure, the force needed to engage or separate the socket contact shall not exceed the following values:

Contact	Max. Force Ounces	Min. Force Ounces
#20	12	2
#16	26	3

FEATURES OF AMPHENOL *MINNIE* CONNECTORS

(1) Environmentally sealed with unitized back end grommet. (Also available with provision for potting.) Grommet seal (type "E") meets altitude-moisture resistance requirements. Either grommet seal or potted seal meets moisture resistance requirements of MIL-C-5015C, Paragraph 4.5.21.

(2) Spring-loaded coupling ring provides a positive locking action in the bayonet slot, and a constant compensating force which eliminates the effects of resilient face seal compression set.

(3) Stainless steel bayonet slots and pins reduce wear and frictional characteristics and eliminate wear encountered with "hard-coat" and similar surface treatments of softer base metals. The three pin bayonet coupling minimizes the rocking action of the mated plug and receptacle.

(4) Flattened incline angle of bayonet slots reduces mating force requirement.

(5) Hooded contacts resist test prod damage as defined in Paragraph 4.5.14 of AMPHENOL Specification 340-43-2108.

(6) Unitized grommet seal; clamp and grommet form a single unit for ease of assembly and maintenance.

(7) Face seal gasket with individual barriers to isolate each contact.

(8) Hard insert dielectric (plus resilient face seal) positively retains contacts with no possibility of contacts being pushed out of the insert.

(9) A visual full engagement indicator is included in the design to insure the user that he has fully engaged the connectors. The indicator is an orange line around the receptacle shell.

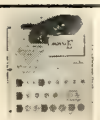
- Insulation resistance of "E" type following altitude-moisture resistance test is a minimum 1000 megohms. MIL-C-5015C minimum following type "E" test is 100 megohms.
- When using mated sealed connectors, no derating for altitude is necessary at 70,000 feet.
- Test voltage 1,500 volts RMS 70,000 feet on sealed connectors.
- Vibration per Method 204 of MIL-Std-202A. 10 to 2,000 cps at 20 g's.
- Temperature cycling range per MIL-C-5015C, Paragraph 4.5.3 increased to 257°F. maximum and −67°F. minimum.

VOLTAGE RATING

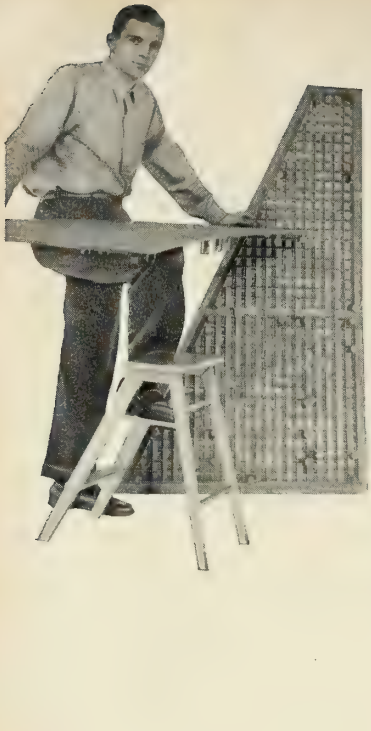
	Rating	Mechanical Spacing (Nominal)	Flashover V-Rms	Test V-Rms	Recommended Working Voltage DC	Recommended Working Voltage AC
Sea level (unsealed)	A	.034	2,000	1,500	700	500
	B	.046	2,300	1,800	840	600
Sea level (sealed)	A	.034	2,500	2,000	700	500
	B	.046	3,000	2,500	840	600
70,000 ft. (unsealed)	A	.034	500	375	175	125
	B	.046	600	450	210	250
70,000 ft. (sealed)	A	.034	2,500	1,500	700	500
	B	.046	3,000	1,800	840	600

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book reviews

SMITHSONIAN CONTRIBUTIONS TO ASTROPHYSICS, Vol. 2, No. 10, compiled by F. L. Whipple, L. G. Boyd, J. A. Hynek and G. F. Schilling, 347 pp., $1.00, Smithsonian Institution, Washington, D.C.

This collection of data, entitled "Orbital Data and Preliminary Analyses of Satellites 1957 a and 1957 b," consists of material (in edited form) which first appeared in Special Reports No. 1 through No. 10 of the Smithsonian Astrophysical Observatory.

Since Oct. 4, 1957, when the first satellite was launched by the USSR, the Smithsonian Institution has compiled and distributed data related to basic research projects. This report includes data on orbits, atmosphere, Moon Watch observations, Soviet predictions and information, and a glossary of astronomical terms.

Many diagrams, charts and photographs are included. The report may be obtained by writing to the Superintendent of Documents, Government Printing Office, Washington 25, D.C.

THE GYROSCOPE APPLIED, by K. I. T. Richardson, M.A. 384 pp., $15, Philosophical Library, N.Y., N.Y.

This book, the first to be published on gyroscopic application since 1946, presents the many technical advances that have been made and embraces as many of the different types of application as possible—ranging from small intricate aircraft instruments to large engineering projects, such as the roll-stabilizers for 40,000-ton liners.

SPACE FLIGHT by Carsbie C. Adams, 392 pp., 50 illustrations, $6.50, McGraw-Hill, N.Y.

The layman, as well as the scientist, will find this survey of the past, present and future of space travel readable and informative. Topics cover the history and background of astronautical sciences and the fields that compose these sciences, including contributions made by the associated fields of astrophysics, communications, geophysics, materials and space medicine.

Mr. Adams discusses many important recent advances, and gives the reader details on new proposals that he feels are worth considerations. These include useful data on space stations, small satellites, moon bases, ion and atomic rocket engines, and advanced research missiles.

The author is president of the National Research and Development Corp., which, at the present, is engaged in astronautical research and development projects.

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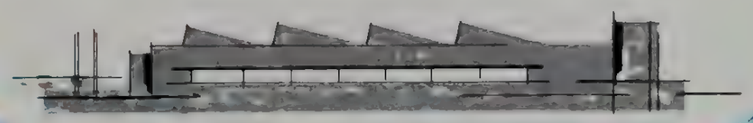
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Clarence H. Weissenstein

Atlantic Research Corporation

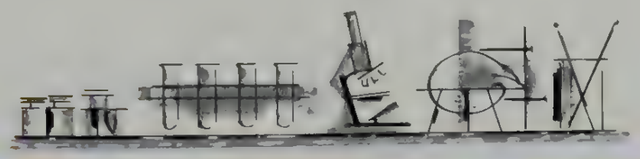
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MIL-J-5624D	JP-5 Kerosene
MIL-F-25656	JP-6 Supersonic Fuel

Referee and Test Fuels

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MIL-F-5161C	Referee (JP-4)
MIL-F-005161D(Aer)	Type I High Volatility Navy Proposed Referee Jet Fuel
MIL-F-005161D (Aer)	Type II Low Volatility Navy Proposed Referee Jet Fuel
MIL-J-5161E	Referee Grade I (JP-4)
MIL-J-5161E	Referee Grade II (JP-5) and (JP-6)

Missile Fuels

MIL-F-25558B	RJ-1 Ramjet
MIL-F-25576A	RP-1 Rocket
MIL-F-19605	BM-1 Rocket

COMMERCIAL SPECIFICATIONS FOR AVIATION TURBINE FUELS

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Allison Div. of G. M.	EMS-64A Kerosene
General Electric	CJ805 Kerosene
Wright Aero. Div. of C. W.	Kerosene
Lockheed Aircraft Corp.	LAC 1-348-1 Kerosene

Consumer Specifications

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Trans-Canada Air Lines	Sp. 481 Wide-Cut
ASTM	Type A Kerosene
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missile business

by Seabrook Hull

Look for some major changes in Air Force's approach to the weapons system concept. Even as Army has modified its operations under the so-called "Arsenal concept" of doing business, so will the Air Force back off somewhat from its former approach to research, development and production of major rocket and missile-based weapons systems.

It is common rumor in Washington (has been for several weeks) that the Air Force is coming to the conclusion that its administrative approach to development of *Atlas, Thor* and *Titan* has been neither the most efficient nor the most economical. And, importantly, AF, like the other two military services, realizes that no matter how efficient procedures become, there will never be enough money "to do all the jobs that need doing."

Indications are that AF, in the future, will rely more and more on individual company capabilities (with certain specific emphasis on small, highly-specialized companies) and less upon "for-hire" systems monitoring.

As proof of this trend, ARDC just last week held a special briefing for selected small business representatives, outlining the problems and requesting original suggestions for "more elegant" *Dyna-soar* follow-on.

This is a new year, just in case you'd overlooked the fact. Even though fiscal 1959's budget has not yet won formal congressional approval, its size and structure is generally known. And, the new year's programs, extensions, and expansions are now beginning to be negotiated. If you've tended to let up a bit during the last few weeks of selling, it's now time to renew the pace in order to get your point across early with government procurement offices, prime contractors, subcontractors. For, even if they haven't gotten their new bundles of money, they soon will, and are already planning how to spend it.

The shake-out in missile and rocket weapons systems forecast by m/r many months ago is far from complete. Look for some shockers. Reports are increasingly persistent, for example, that the most *Titan* will ever be used for is space flight research; that emphasis instead will be switched to the solid propellant *Minuteman.* Point is: Don't tie all your corporate planning to one big project, lest you find yourself suddenly with all those facilities and little else but contract termination proceedings.

The day of the political or "mobilization base" bailout obviously isn't ended yet, but its hours are numbered. You've only to note rumblings in the Pentagon and on Capital Hill that we can afford less and less to grant contracts to this or that company primarily "because it needs business," or "because we (the taxpayer) have a big investment there."

contract awards

NAVY

By Office of Naval Research:

Carnegie Institute of Technology received $46,362 for research in inorganic solids.

Columbia University received $33,839 for research to develop the theory of probability and its applications.

New Mexico College of Agriculture and mechanical Arts received $42,671 for mid-atmosphere rocket research.

Northwestern University received $256,660 for research on physical changes resulting from imperfections in solids.

Radio Corp. of America received $148,632 for research leading to the development of a microwave amplifier tube.

Harvard College received $35,000 for research dealing with an investigation of crystal imperfections by X-ray diffraction.

University of California received $519,800 for research in marine physics.

Wayne State University received $27,000 for research in the statistical theory of life and fatigue testing aspects of reliability.

Leland Standford, Jr. University received $26,000 for research on radiation induced free radicals of short lifetime.

University of Michigan received $51,682 for research in the field of high energy physics.

University of California received $36,900 for research in differential equations.

Leland Standford, Jr. University received $35,000 for research on new methods for the computation of eigen values.

University of California received $27,500 for research in differential equations occurring in wave propagation and coupled oscillations.

By Puget Sound Naval Shipyard:

Sargent Engineering Co. received $42,276 for spare parts for missile launching system.

By District Public Works Office, 11th Naval District:

L. F. Stilwell & Co. Inc. received $1,413,989 for construction of *Regulus* II facilities, Naval Air Missile Test Center.

By District Public Works Office, 1st Naval District:

Boston Bldg. & Construction Corp. received $209,990 for guided missile support facility.

AIR FORCE

By Cambridge Research Center, ARDC:

Burroughs Corp. received $69,383 for design and construction of a feasibility model of a remote electronic alphanumeric display.

New York University received $39,598 for research of radio wave propagation in variable media.

University of Illinois received $37,500 for studies in dectromagnetic wave interaction technique.

Transistor Applications, Inc. received $39,999 for research directed toward the study, analysis and design of transistor circuits.

High Altitude Observatory of the University of Colorado received $38,400 for study of ionospheric effects on radio signals from satellites and extra-terrestrial sources.

Baird-Atomic, Inc. received $34,977 for research concerning an optical coordinate conversion system.

Philco Corp. received $78,983 for research directed toward growth of silicon crystals.

Massachusetts Institute of Technology received $60,000 for procurement of neutron activation facilities, equipment and consultation services.

General Dynamics Corp., General Atomics Div., received $66,019 for research in radiation damage in semiconductors.

Victory Engineering Corp. received $55,665 for research and development of pressure measuring devices for high altitude

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. . . contracts

balloon-borne systems.

By Cmdr., HQ AMC, Wright-Patterson:

AVCO Mfg. Corp., Crosley Div., received $101,724 for accelerated flight tests of radio beacon.

Missile Development Div., North American Aviation Inc., received $541,591 for completion of the development and refinement of the steel "plymetal" sandwich production type machinery.

Syracuse University Research Institute received $27,581 for services and materials necessary to establish the chemical mechanism of scale removal from titanium alloys.

Goodyear Aircraft Corp. received $6,354,348 for nose sections, spare parts and data for the TM-76A missile.

Lockheed Aircraft Corp. received $480,000 for modification of C-130A airplanes to *Drone* missile launcher.

International Business Machines Corp., Military Products Division, received $238,907 for advanced bombing navigational missile guidance system surveillance program.

Thiokol Chemical Corp. received $749,944 for product and engineering improvement of the GAR falcon rocket engine.

David Clark Co., Inc. received $150,000 for full pressure altitude suits.

Perkin-Elmer Corp. received $97,950 for development of a flight type radiation pyrometer for exhaust gas temperature measurement.

Cincinnati Milling & Grinding Machines, Inc. received $105,004 for dealers' services covering five skin mills.

By HQ, AFOSR, ARDC:

California Institute of Technology received $42,000 for research on "the physical properties of metals and alloys at elevated temperatures."

Fordham University received $39,992 for research on "chemistry and phototrophy of sydnones".

Carnegie Institute of Technology received $103,937 for research on "conformal and variational methods".

University of Wisconsin received $29,838 for research in the general field of properties of metal-ion complexes.

Tufts University received $28,290 for research on "initial reaction intermediate in the ozonation of alkenes".

Polytechnic Institute of Brooklyn received $30,530 for continuation of photochemical reactions in plastics.

Cornell University received $58,000 for X-ray spectroscopic studies of the solid state.

Johns Hopkins University received $91,766 for study of plastic wave propagation in metals at elevated temperatures.

Ohio State University received $84,504 for research on "electrical properties of high-purity boron".

Alfred University received $59,836 for research on "correlation between the defect solid state and catalysis".

Aerojet-General Corp. received $66,155 for "investigation of atomic oxygen recombination rates".

Indiana University received $51,800 for quantum mechanical studies of the nature and interactions of simple atoms and molecules.

Massachusetts Institute of Technology received $78,750 for research on "neutron diffraction studies of solids".

American Mathematical Society received $53,414 for "reports on current mathematical developments and their application to related sciences".

University of Rochester received $56,000 for research concerning "phenomena surrounding high speed flight".

Leland Standford, Jr. University received $180,000 for research on whistlers and related low frequency radio wave phenomena; $146,329 for research in paramagnetic resonance.

Cornell University received $54,135 for investigation of atomic phenomena occurring on or near the surface of solids.

The William M. Rice Inst. received $33,850 for research on "effects of vibrations on lattice imperfections movements in metals".

Massachusetts Institute of Technology received $50,000 for continuation of "research on some unsteady aerodynamic and non-linear structural problems of aircraft".

Leland Standford, Jr. University received $175,000 for research on "nuclear photoeffects, meson field, and electron scattering".

Columbia University received $29,190 for investigation of the nature of fracture in metals.

Leland Standford, Jr. University received $1,245,000 for interaction of microwaves with matter.

University of North Carolina received $43,616 for "research in non-parametric statistical inference"; $69,742 for research on "design of experiments".

George Washington University received $32,477 for a study of the reactions between alkali metals and carbon monoxide.

North American Aviation, Inc., Rocketdyne Div., received $95,490 for experimental studies of electrical propulsion.

Yale University received $70,000 for research in "functional equations and spectral theory".

Ohio State University Research Foundation received $28,710 for research and reports concerning "compounds containing trihalomethyl groups".

Phillips Petroleum Co. received $149,388 for continuation of studies leading to production, stabilization, concentration and storage of highly reactive chemical species.

University of Illinois received $45,032 for research on "investigation into the laws underlying human behavior in complex tasks having multiple stimulus, multiple response demands".

ARMY

By Cincinnati Ordnance District:

Purdue Research Foundation, Purdue University, received $30,418 for basic research program on the variational approach to the re-entry problem.

By Ordnance District, Los Angeles:

Firestone Tire & Rubber Co. received $68,270 for replenishment repair parts for guided missile, artillery M2 and related ground handling equipment; $34,972 for spare parts for the *Corporal* missile system.

North American Aviation, Inc. received $25,500 for rocket engines.

Sandberg-Serrell Corp. received $26,661 for design of hypersonic wind tunnel.

California Institute of Technology received two contracts totaling $3,801,000 for engineering research and development relating to guided missiles, free rockets materials and wind tunnel operation.

Wallace O. Leonard received $49,875 for lox tank computer.

Gilfillan Bros. Inc. received six contracts totaling $704,626 for repair parts for the *Corporal* missile system.

Firestone Tire & Rubber Co. received $54,000 for guided missile surface-to-surface systems.

Douglas Aircraft Co., Inc. received $79,203 for *Honest John* improvement program; $73,176 for repair parts for *Nike* system; $46,949 for pump, vacuum, lox tank, equipment installation.

Redel Inc. received $39,905 for igniter study.

Rheem Manufacturing Co. received $288,185 for work regarding Zebra III.

Firestone Tire & Rubber Co. received two contracts totaling $241,555 for replenishment repair parts for guided missile, artillery M2 and related ground handling equipment.

Gilfillan Bros. Inc. received two contracts totaling $184,504 for furnishing of depot replenishment repair parts for the *Corporal* missile system.

Grand Central Rocket Corp. received $60,514 for dart, rocket motors and igniters.

Ralph M. Parsons Co., Electronics Div., received $36,286 for decommutation stations.

Reed-Curtis Nuclear Div., American Electronics, Inc., received $26,583 for detector.

North American Aviation, Inc. received $30,000 for rocket engines.

Aerojet-General Corp. received $33,472 for study and design of a new missile systems test facilities for solid propellants.

California Institute of Technology received $732,868 for engineering research and development.

Firestone Tire & Rubber Co. received $689,683 for *Corporal* handling and launching equipment.

Douglas Aircraft Co. Inc. received $181,873 for repair parts for *Nike* system.

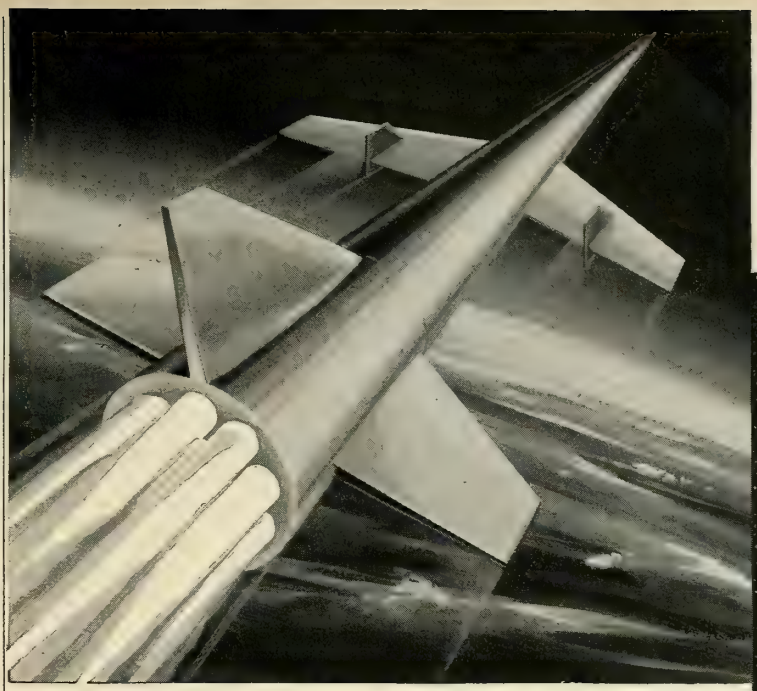
Telemetering Corp. of America received $188,317 for telemetry system.

Radioplane Co. received $47,154 for supplies and services relative to missile targets.

Rheem Mfg. Co. received $816,862 for *Nike* warhead and fuze.

California Institute of Technology received $80,000 for hypersonic research. Gilfillan Bros. Inc. received $63,609 for emergency and Blue Streak.

North American Aviation, Inc. received



Engineers—Scientists

The Bell Aircraft *Rockets Division* forges ahead with new types of rocket engines and propellents to provide the higher thrust and greater efficiency needed to push missiles, satellites and manned space vehicles through the earth's atmosphere into outer space.

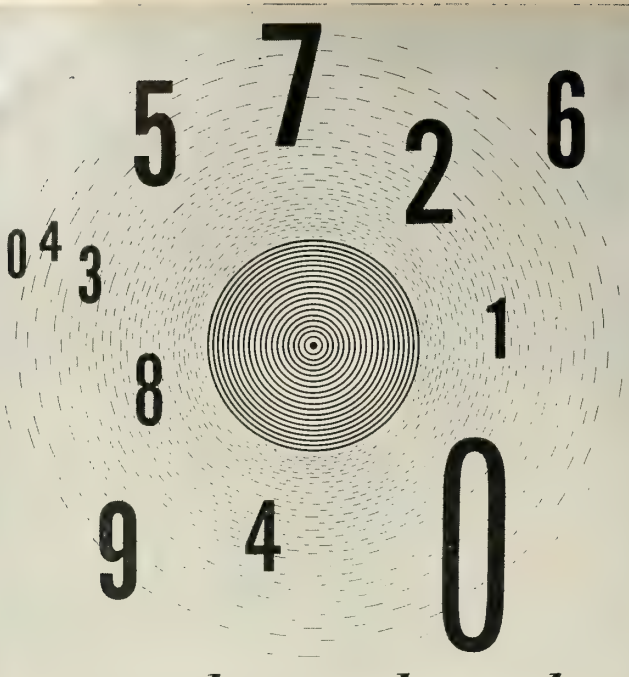
These programs are the outgrowth of over a decade of Bell experience in rocketry, beginning with the record-breaking X-1 and X-2 supersonic rocket-powered aircraft, and continuing with the development of rocket power plants for projects like the Rascal air-to-surface missile.

Continued growth and expansion in the *Rockets Division* have opened a number of select positions in the following fields:

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Combustion and Fuels Research
Systems Installation
Structural Analysis
Instrumentation
Rotating Machinery
Controls Development
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. . . contracts

two contracts totaling $311,454 for rocket engines.

Giannini Research Corp. received $158,575 for material testing relative plasma jets; $88,446 for facilities.

California Institute of Technology received $812,448 for engineering research and development.

By Signal Supply Agency:

University of Illinois received $39,936 for research work to study measurement of intensity of surface precipitation by means of analysis of radar returns.

Ramo-Wooldridge Corp. received $157,436 for research work to study and investigate automation techniques for electrical and electronic equipment testing.

TRG, Inc. received $64,820 for missile-air and submarine-borne cesium beam frequency standard type A.

Chatham Electronics Div., Tung-Sol Electrical Instrument Co., received $27,344 for research of electron tube glasses resistant to radiation damage.

Aeronutronic Systems, Inc. received $482,050 for additional research in the guided missile instrumentation field.

Stanford Research Institute received $65,518 for research work on missile tracking antenna systems.

Cooper Development Corp. received $27,003 for rocket motors.

Western Electric Co. received $49,566 for experimental, development and research work.

General Electric Co. received $62,738 for research investigation to continue development of super power thyratron tubes.

Melpar Inc. received $75,000 for transponder set; $84,825 for research work to conduct a study of input-output equipment.

United Research Inc. received $34,121 for research to conduct a study of wind shear measurements.

Hallomore Electronics Co. received $90,000 for complete microlock receiving station.

Haller, Raymond & Brown received $102,873 for ground infrared image scanner.

Admiral Corp. received $61,095 for engineering services on television systems for tracking guided missiles.

Polytechnic Institute of Brooklyn received $193,160 for fabricating mm wave guides components.

Armour Research Foundation of Illinois Institute of Technology received $88,391 for research study and investigation on wave propagation under anomalous conditions.

Polytechnic Institute of Brooklyn received $59,540 for research on X-band high power ferrite type duplexer.

Linden Laboratories received $46,198 for high K-ceramic materials.

Grand Central Rocket Co. received $67,500 for rockets, solid propellants.

University of Minnesota received $87,022 for study of noise in semi-conductors and semi-conductor devices.

Collins Radio Co. received $98,114 for research covering study and investigation of radio interference and field intensity instrumentation techniques.

Bendix Aviation Corp. received $561,574 for high speed data terminal.

Lansdale Tube Co., Div. of Philco Corp., received $73,811 for research directed toward germanium PNP or NPN junction transistor.

University of Michigan received $240,000 for a ground station capable of tracking rockets.

Autonetics, Div. of North American Aviation Inc., received $94,550 for recomp II computer.

Advanced Electronics Mfg. Corp. received $31,400 for twelve self-checking digital data transmitters.

Western Electric Co., Inc. received $542,560 for a study of industrial preparedness measures covering solid state devices.

International Resistance Co. received $261,483 for industrial preparedness measure for metal film potentiometers.

By Defense Supply Service:

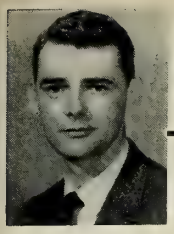
Ivel Construction Corp. received $28,411 for 253 full size "*Explorer* I" mock ups.

By U.S. Atomic Energy Commission:

Watkins Construction Co. received $316,019 for initial engine test modifications, aircraft nuclear propulsion project at the national reactor testing station in Idaho.

By Military Clothing and Textile Supply Agency:

Seymour Wallas & Co. received $126,666 for hood, rocket fuel handler's vinyl coated cloth.



astrionics

by Raymond M. Nolan

The recent switching around of various guidance assignments has many observers wondering if there isn't some sort of master juggling plan going on. First GE was awarded the *Polaris* guidance contract and then dropped from the *Atlas* program. Kearfott was to have supplied the gyros for the GE-*Atlas* guidance, but now they are listed as a guidance sub-contractor on the *Subroc* program.

Arma is the guidance supplier for both the *Atlas* and later *Titans*, with Bell Labs supplying the back-up radio-inertial sets for use in the first dozen or so *Titans*.

Ramo-Wooldridge has received a contract from the Army. Amount was $13.5 million for the installation and operation of an automatic data processing system at the Army Electronic Proving Ground in Arizona.

RCA has announced a basic improvement in parametric microwave amplifiers. In the new device, a germanium diode is used to detect the incoming signal, and either a transistor or a "pencil-type" tube oscillates at a lower frequency to provide a pumping action for amplification. Previous parametric microwave amplifiers have been hampered because they required a pumping frequency higher than that of the signal to be amplified.

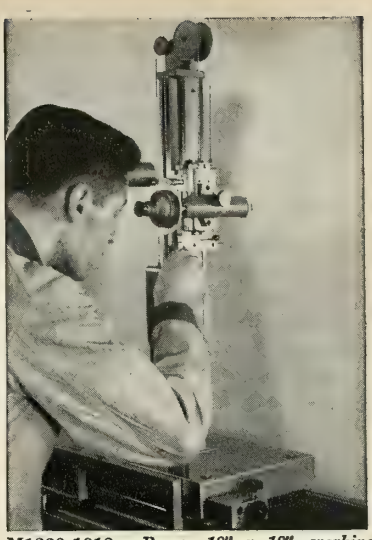
Since the new amplifier does not require the low temperatures or strong magnetic fields of MASER, and can operate on a power input of a fraction of a watt, RCA people see definite future missile uses for the four cubic inch device.

The first all-overwater microwave installation has been completed on the missile range at Cape Canaveral. Motorola, the contractor, stated that the system operates in the 7125-8000 mc band, and covers a total of 80 miles in the Bahama Islands, connecting three missile tracking sites. The installation consists of two microwave links which tie into a pair of terminals at Bassett Cove on the submarine cable to the mainland.

Union story of the week—The largest local of the Teamsters Union is located in the Aero Division of Minneapolis-Honeywell, Inc. However, company union officials are quick to point out that there is very little "contact" between the local and the parent organization.

Next step in the art of inertial guidance will probably be the gimballess stabilized platform. This is not a platform at all, but rather three gyros oriented to three stabilizing axes, and fixed to the frame of the missile. The gyros would sense missile deviation and send correction signals to the control system.

The big problem is orientation of accelerometers. Without a stable platform to provide a fixed measuring reference, the problem becomes one of monitoring the gyro signals to the control system and computing changes in orientation of the accelerometers, so that measurements of accelerations are correct.



M1238-1818 — *Range 18" x 18", working distance 9" to infinity. Reads to 0.001" up to 24" working distance. Protractor ocular reads to 3 minutes of arc. Image is erect.*

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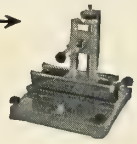
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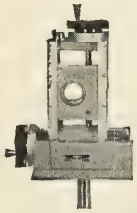
These convenient, reliable optical instruments permit making precise coordinate measurements in a vertical plane. The two dimensions are measured with one setting, object does not have to be rotated. Inspection time is cut in half and resetting errors eliminated.

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Because these are optical rather than mechanical measuring instruments, you make non-destructive measurements without contact, distortion, or concern about pressure being applied to the object when making a setting. Instruments available in English or Metric system.

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M1236-22— Range 2" x 2", reads to 0.0001". Working distance 5" to infinity. Shown with 19 mm mounting rod, and without telemicroscope. Instrument permits precise coordinate movement of other objects such as photo cells, probes, etc., in place of telemicroscope.

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missile miscellany

Dyna-Soar's like the weather: Everyone talks about it but very little is being done about it—except, of course, to study it. With both the Boeing and Bell-Martin teams ordered back for another "6-to-12 months" of study (see p. 34), it's a good bet that the Russians will be flying a skip-bomber before we've got the blueprints finalized. A top-level Bell engineer bitterly comments: "We've done all the studying. We're ready to build hardware." And, from a Boeing excutive: "We've got this one sewed up!"—the contract, he means. Still another remark (this column has been traveling) about Martin-Bell group: "It was a shotgun wedding . . . AF thinks Martin has management; Bell, technical knowhow." Other Dynasoaric odds and ends: Four Minuteman first stages being considered as possible initial booster for the glide bomber, whose leading edges may be made of Norton Company's Crystolon-R, a recrystalized silicon carbide taking prolonged 3,000°F exposure.

And while we're on materials, ablation is the word for reentry, and one of the best ablating materials yet is a phenolic resin developed by Cincinnati Testing and Research Laboratory—paired with asbestos, it is the outer coat for Jupiter's nose cone; is slated for Polaris and is being considered for Titan, Atlas and Thor by GE and AVCO.

Two smaller versions of the $185,000 Monarch "Missile Master" lathes (90-inch facing plate; 25 feet between centers; air gage tracer plus Keller), specified and first ordered by Diversey Engineering, have now been ordered by Aerojet-General as part of its facilities program for establishing complete in-the-house missile-metal machining capability . . . Ingersoll-Kalamazoo div., Borg-Warner, is now hydro-spinning nozzle and 110-inch-long Nike booster casing from a single cylindrical blank.

And plastics: This column learns that Allegany Ballistics Laboratory's third-stage Vanguard rocket (with all plastic casing) not only gives higher performance than Grand Central's metal-encased motor, but is also reliable. The motor is scheduled to supply third stage power for AF's Thor-Able moon shot; designed to send 32-pound payload around moon. Incidentally, this page wonders why AF is wedding Vanguard second stage motor to costly Thor, when it's never really had a chance to prove itself in flight; also, why AF doesn't mount an X-17 on Thor instead—since X-17's proved itself 92% reliable in flight.

Conflicting reports abound on Thiokol: With RMI, Hunter-Bristol and National Electronics Laboratories under its belt (or wing), Thiokol's well set to bid on, and get, a major prime systems contract. Now all-of-a-sudden, this bit of scuttlebutt: Thiokol top management is looking for a merger or somesuch with a BIG chemical firm in order to expand its working capital . . . Further word: That Northrop may buy out American-Bosch-Arma.

And via the underground railway, opinion by top Soviet IGY scientists that space-pooch Laika, in fact, baked to death. Also, this significant reply to a query about how many Russians would attend next month's IAF Congress in Amsterdam: "Only four. We've got too much work to do here" . . . And, in closing, this page hears it's now powder horns and flintlocks for the Green Mountain Boys . . .

S.H.

EIA Elects Electronics Executive President

David R. Hull, an electronics industry executive for the last ten years, was recently elected president of the Electronic Industries Association.

A vice president of defense programs of the Raytheon Manufacturing Co., Mr. Hull was formerly with IT&T as vice president and director of the Federal Telecommunication Laboratories, and executive vice president and director of Capehart-Farnsworth Corp. He now is also a director of Technical Operations, Inc., and of Raytheon Canada, Ltd.

Cutler-Hammer Acquires Airborne Instruments Lab

The acquisition last month of Airborne Instruments Laboratory, Inc., Mineola, N.Y. electronics company by Cutler-Hammer Inc., combines the research, engineering, production, and marketing talents of a 66-year-old blue chip electrical control firm with those of a 13-year-old blue yonder electronics firm.

Under the terms of the agreement, AIL will operate as the Electronics Division of Cutler-Hammer, retaining its name, officers, management, personnel, and line of business.

Cutler-Hammer, a leading manufacturer of electrical control equipment, has 6,000 employees and is headquartered in Milwaukee. Airborne, presently employing 1,500, is a leader in research and development, specializing in the application of electronics to radar, microwave, and data-processing equipment.

The first AIL plant will be located at Melville, Long Island, N.Y. The new plant will house the Research and Engineering Division and general administrative offices of AIL. Plans for AIL's Engineering and Production Division are to continue in their present facilities located in Long Island, N.Y.

Future ICBM Guidance To Be All-Inertial

Pentagon sources have revealed that the *Titan* guidance system will be used on the *Atlas* missile. The system, almost ready for operational use, is being manufactured by Arma division of American Bosch Arma and Minneapolis-Honeywell.

First units off the production line will go into the *Atlas*. The *Titan* will use the Bell Laboratories back-up radio-inertial system. The *Titan* system (described in m/r, May 1958) uses a frame-fixed platform and gyros manufactured by Minneapolis-Honeywell for the first 300 seconds of flight, and then switches to the Arma pure inertial system.

The radio-inertial system, similar to that planned for use on the *Thor* and later cancelled when AC Spark Plug's Achiever system proved adequate, will satisfy all requirements of the *Titan* during the test phase. However, present plans call for the straight inertial system when *Titan* becomes operational.

No mention was made of the role General Electric and Burroughs Company will play in future ICBM

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APL's past accomplishments include: the first ramjet engine, the Aerobee high altitude rocket, the supersonic Terrier, Tartar, and Talos missiles. Presently the Laboratory is engaged in solving complex and advanced problems leading to future weapons and weapons systems vital to the national security. Interested engineers and physicists are invited to address inquiries to:

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Applied Physics Laboratory

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high-energy fuel briefs from Callery

Two new plants for the production of HiCal,® High Energy Fuel, are under construction at Lawrence, Kansas and Muskogee, Oklahoma. The first shipment of HiCal 3 will be made from our Lawrence, Kansas plant about August 1. Two of the units for the production of HiCal intermediates were put into operation in April. Virtually all the fuel from the Lawrence plant is committed now. There may, however, be quantities of HiCal available in the future for authorized users.

Construction of the Navy HiCal facility at Muskogee, Oklahoma is on schedule and the plant should be finished by the end of 1958. Callery will operate this plant and the Navy will distribute the fuel.

Triethylborane: new pyrophoric fuel — TEB is spontaneously flammable in air, but stable in water. Density at 25°C is 0.68. Melting point is −92.5°C. Boiling point is 95°C. Heat of combustion is 20,200 B.t.u./lb. It is miscible with hydrocarbons, so it can be used as an additive to conventional fuels.

Triethylborane in weapons systems — TEB burns at much lower atmospheric pressures than hydrocarbon fuels. Thus, weapons systems, with TEB as a fuel, can fly faster, at higher altitudes, with leaner mixtures, and therefore with better fuel economy and increased reliability. High altitude flameout can virtually be eliminated. Expenditures for airframe can be greatly reduced — power plants can be built smaller, more simply. In concentrations of 15%, or even up to 30% in JP fuels for small-size units, the additive approach improves burning and reduces screech in rockets.

Other fuel possibilities — Callery can also produce Decaborane, Pentaborane, and Diborane, but these materials are in limited supply at present.

The Amine-Boranes, R_3NBH_3, should also be considered as liquid or solid fuels or as additives to hydrocarbon systems in missile and rocket propulsion.

Samples and specific data available — Specific data on HiCal is classified and "need to know" must be shown. We will be glad to talk with you about the technical aspects of any of the other compounds mentioned above. And we can provide test quantities for specific end-use evaluations. Just write or call.



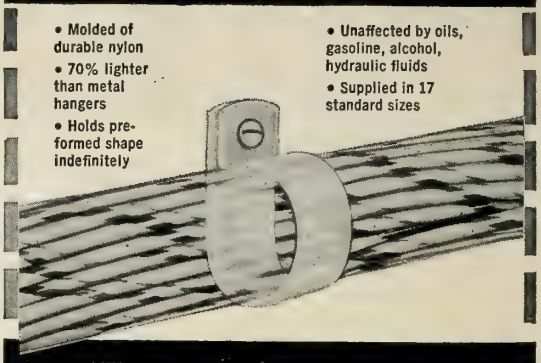
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guidance manufacture, but it is understood that these developers of the present *Atlas* radio-inertial system still have active contracts on which no termination action has begun.

Litton Industries Purchases Airtron

Negotiations have been completed and an agreement signed for the purchase of Airtron, Inc., by Litton Industries, Inc., it was recently announced. The transaction involves the exchange of an undisclosed amount of both common and preferred Litton stock for 100% of Airtron stock. Consummation of the exchange agreement is expected to take place by August 1, 1958.

Airtron's current annual sales rate has been approximately $10 million. The acquisition will add to the Litton organization Airtron plants in Linden, N.J. and Cambridge, Mass., where Airtron employs over 800 people in the development and manufacture of radar and other microwave communication components and equipment.

According to Litton, Airtron management will remain with the operation as it becomes a Division of Litton. David Ingalls will continue as president of Airtron and will become a vice-president of Litton.

Air Force Awards SAGE Contract to Burroughs

U.S. Air Force has announced a $17 million contract award to Burroughs Corp. for the construction of 24 coordinate data processing systems to be used in the SAGE system of continental air defense.

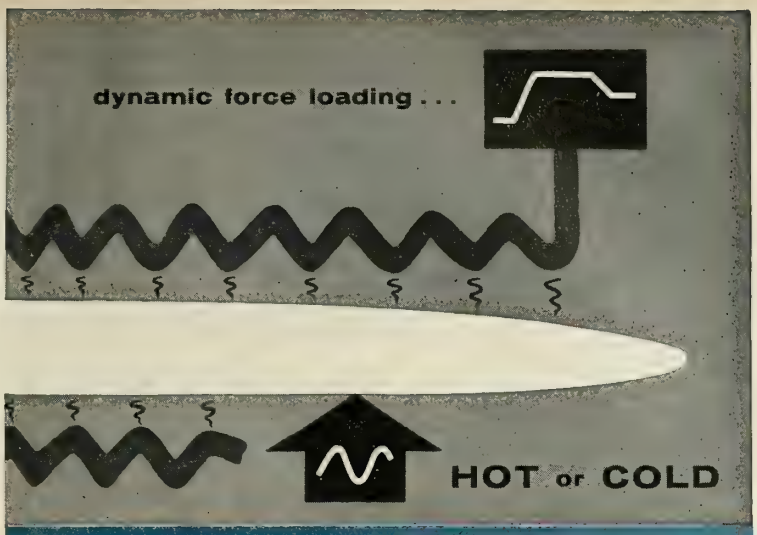
SAGE (Semi-Automatic Ground Environment) is a nation-wide system that combines radar, electronic digital processing systems and highspeed communications to detect the approach of hostile aircraft or missiles and direct a counterattack.

The first completed system will be installed at McGuire AFB, N.J.

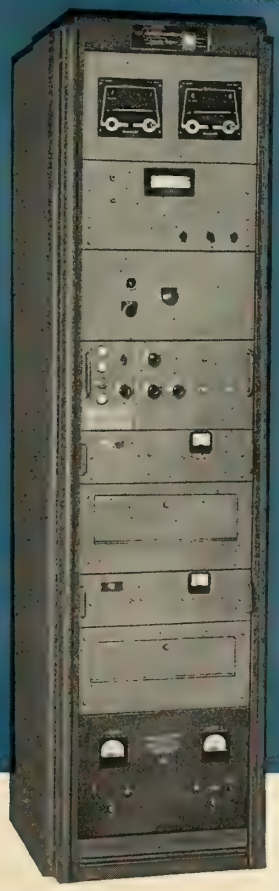
AF Electronic Scoreboard Contract Awarded to IT&T

A 300-mile electronic "scoreboard" for testing anti-aircraft missiles will be built on the gulf coast of Florida under a $5.6 million Air Force contract awarded to International Telephone & Telegraph Corp.

The installation will be made at Eglin Air Force Base, Air Proving Ground Center, near Fort Walton Beach, Fla. The range will stretch



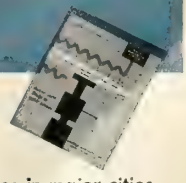
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southward into the Gulf of Mexico, parallel to major tracking sites at the Florida shore points of Cape San Blas and Anclote. Known as Eglin Gulf Test Range, the three stations will provide complete missile control and safety.

The installation will include radar equipment for instrumentation and safety tracking, telemetry systems for obtaining data from missiles and aircraft, optical systems, drone tracking and control systems, data transmission equipment and countdown systems.

"Dick Tracy" Radio Aids Missile Work

A transistorized radio, smaller than a cigarette pack, is being used by Chance Vought technicians and movie cameramen to keep tab on guided missile flight preparations.

The set, which is operated by two pencil flashlight batteries and has a flexible cat-tail antenna, is mounted on an ear-protector headset used to cut the effect of pre-launch noise. The receiver is tuned to the primary frequency used for missile launching countdowns.

Space Technology Courses Offered at U. of Calif.

Two new intensive courses on space technology will be given in August at the University of California at Los Angeles by the engineering and physical sciences extension. A course in Astrodynamics and Rocket Navigation will take place August 4 through 15, and will consider the development of acceleration equations for gravity, thrust and drag in inertial and rotating systems applicable to the study of satellites and other space vehicles.

Fundamentals of Rocket Propulsion will be analyzed August 18 through 29. Both courses will meet daily from 8 a.m. to 5 p.m. Participants must have a bachelor's degree in a physical science or in engineering. Applications may be obtained from University of California Extension, Los Angeles 24, Calif.

Stanford Accelerator Power Raised to Billion Volts

The Mark Three linear electron accelerator at Stanford University will be lengthened from 220 ft. to 310 ft., and the power increased to over one billion electron volts. The project, which was scheduled to begin last month (June) will cost $850,000. It is sponsored by the Air Force office of Scientific Research, the Office of Naval Research and the Atomic Energy Commission.

Plans for a bigger multibillion-volt linear accelerator are now awaiting approval of interested government agencies, according to the university's top officials.

Canadian Navy To Use *Sidewinder* Missile

Guided missiles will be fitted to the Royal Canadian Navy's Banshee jet fighter aircraft, the Royal Canadian Navy has announced. The Navy has adopted the *Sidewinder*, the U.S. Navy's newest air-to-air guided missile as armament for its two fighter aircraft squadrons.

The Navy said that the *Sidewinder* was selected because of its suitability for the Banshee and its early availability. Only slight modification of the aircraft will be needed to accommodate this new weapon.

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industry countdown

• **The $38 Billion FY 1959 Defense Budget** will probably be hiked by Senate, but only part of "extras" requested will be okayed . . . Meanwhile, USAF spending for missiles, at 30% of total AF procurement budget in 1959, is up 3% from 1958, while aircraft, at 47% is off 1%. AF ballistic missile funds for 1959 total $891.7 million, while $1.010 billion is slated for non-ballistic missiles including *Snark, Bomarc, Falcon, Sidewinder, Hound Dog, Goose, Quail, Falcon* and *Mace*. . . . **Also in USAF Budget** is $130 million for facilities; $728 million for R&D, plus another $15 million for *Minuteman*.

• **On Capitol Hill,** a bill (S. 4105) has been introduced to force Pentagon to give 60% of military aircraft and missile repair work to private industry; will result in a long study, no action this year . . . **Hearings have begun** on H. R. 8002 to put government on an accrued expenditures basis . . . **Congressional Record for June 30** gives Rep. C. King's (D-Calif.) idea of how his bill (H. R. 13092) would update renegotiation from a wartime measure to present-day conditions; you can order a copy from Superintendent of Documents, Government Printing Office, Washington 25, D.C. . . . **Same outfit will sell** you ($1.00) an unclassified "Register of Planned Mobilization Producers", listing 18,000 plants. . . . **Before Senate Armed Services Committee, Defense Secretary McElroy** commented missile program has been wasteful because "we have produced more missiles than were needed and we've duplicated in a way that was wasteful . . ."

• **First Operational Snark** was fired June 19 from Cape Canaveral. . . **Boeing Airplane Co. will deliver** the first Bomarc for the Air Proving Ground Center missile test range at Eglin AFB this month . . . **AF's 865th Strategic Missile Squadron (IRBM-Jupiter)** will start training at Huntsville, Ala., this fall, about the time the 864th completes training at Army Ordnance Guided Missile School . . . **Army apparently has awarded study contracts** for two new missiles: a *Little John* successor; a missile to replace 40 mm antiaircraft gun and called *Mauler*. A third Army missile project is being held up due to possibility that a British design may do the job . . . **ARDC will launch** *Manhigh III* **this summer at Crosby, Minn.,** for follow-on studies resulting from the 102,000-feet, 32-hour flight last year . . . **ARPA has place a study contract** with GD's Atomic Division for study of a "bomb-powered rocket" which would rely on series of nuclear explosions for its propulsion . . . **Bell Aircraft Corp. has received a WADC contract** to develop flight instrumentation for space vehicles.

• **A million-dollar recently completed expansion** in countdown consoles now permits three long-range missiles to be counted down simultaneously to minus one hour at Cape Canaveral, where before only one could be handled at a time. . . **USAF Air Materiel Command has reorganized** its Inglewood, Calif. Ballistic Missiles Office as a result of accelerated production of big birds.

• **The 93.4% of Grand Central Rocket Co. stock** purchased by Tennessee Gas Transmission has been transferred to Petro-Tex Chemical Corp. which is jointly owned by TGT and Food Machinery and Chemical Corp. . . . **United States Chemical Milling Corp. has purchased** all outstanding stock of Paul Omhundro Co.—follows earlier purchases of Missile-Air and Hydro Metal Spinning, Foto-Etch Circuits. . . **Diversey Engineering Co. has purchased** assets of Warrior Tool & Engineering and leased an additional 40,000 square feet of Lincoln Mills as part of establishment of operations in Huntsville, Ala. . . . **Rocketdyne** is installing a numerically controlled missiling machine at Neosho . . . **Hofman Laboratories has acquired** a new 22,000-square-foot plant in Hillside, N.J. as part of general expansion . . . **Cornell Aeronautical has leased** a new 60 x 80-foot hangar at Las Cruces, N.M. municipal airport for Lacross testing. . . **Beckman Instruments, Inc., has sold** its Helipot Div plant at Newport Beach, Calif.; its activities transferred to Fullerton, Calif.; will do same with Liston-Becker Div. at Stamford, Conn.

• **GE has bought** 135 acres of land, 14 buildings and 3 million square feet of space from Electric Autolite at Evansdale, O., part of which facilities it had been leasing . . . **GE has bought** 45-acre site near Santa Barbara where it plans $4-million research plant for its Technical Military Planning Operation . . . **AF's $400,000 rocket engine test facility** for backing up X-15 development is nearing completion; X-15 will initially be equipped with two XLR-II RMI engines such as those in X-1, with regular power plant due for installation later.

advertiser's index

Acme-Newport Steel Co.	4
American Latex Products Corp.	16
American Machine & Foundry Co.	17
Ampex Corp.	26
Amphenol Electronics Corp.	44, 45
Ashland Oil & Ref. Co.	47, 48, 49, 50
Atlantic Research Corp.	46
Baldwin-Lima-Hamilton Corp., Loewy-Hydropress Div.	15
Morris Bean & Co.	46
Bell Aircraft Corp.	53
Brush Instr. Div., Clevite Corp.	23
Burndy Corp.	58
CDC Control Services, Inc.	59
Callery Chemical Co.	58
Coleman Engineering Co., Inc.	56
Delco Radio Div., G. M. Corp.	38
Edgewater Steel Co.	41
Thomas A. Edison Industries, Inc., Instrument Div.	18
Electro Instruments, Inc.	64
Electro-Snap Switch & Mfg. Co.	36, 37
Funk and Wagnalls	42
Gaertner Scientific Corp., The	55
General Electric Co.	39
Hallamore Electronics Co., Div. of The Siegler Corp.	35
Humphrey, Inc.	33
Hunter Mfg. Co.	40
Johns Hopkins University	52, 57
Kearfott Co., Inc.	54
Koontz-Wagner Electric Co. Inc.	57
Loewy-Hydropress Div., Baldwin-Lima-Hamilton Corp.	15
Mallory-Sharon Titanium Corp.	6
Minneapolis-Honeywell Regulator Co., Micro-Switch Div.	8
Narmco Resins & Coatings Co.	63
Non-Linear Systems, Inc.	2
On Mark Couplings, Div. of On Mark Engineering Co.	42
John Oster Mfg. Co., Avionic Div.	29
Perkin Elmer Corp., The	10
Robertshaw-Fulton Controls Co.	43
Tube Methods, Inc.	34
Voi-Shan Mfg. Co.	3
EMPLOYMENT SECTION	
Bendix Aviation Corp., Bendix Products Div.	60
General Electric Co.	60
Republic Aviation Corp., Guided Missile Div.	61

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EXIBLE MAGNET WIRE. Ready-toe, flexible magnet wire with a conserative duty rating of 1,000°F for conuous operation. Will withstand temratures to 1,700°F for a limited time d requires no heat treatment or curg prior to use. Hitemp Wires, Inc.
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AGNETIC AMPLIFIER. Highly sensire proportional magnetic amplifier to ovide reliable temperature control for vices such as hermetic integrating roscopes. Designated the PA4A-1, the it is capable of proportional control up to 150 watts output power with put power of a few milli-microwatts. sing a combination of proportional d integral control, an input signal of less than 1 microampere will produce full power output. Magnetic Controls Co.
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NICKEL CADMIUM STORAGE BATTERIES. Reliability and long-life are featured in a series of improved sintered plate nickel cadmium storage batteries. Low internal resistance (0.001 ohms for 10 AH type cell) permits high discharge current. Nicad Div., Gould-National Batteries, Inc.
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REED GAGE. Multiple recording accelerometer developed specifically for obtaining the response spectrum (peak acceleration versus frequency) of structures subjected to high acceleration loads. Unit is self-contained and has eight sensing elements, each with a single degree of freedom along the same axis. Each element also has a different natural frequency, and is capable of sensing and recording the acceleration to which it is subjected. Frequency range of model #440 is 950-2000 cps. Unit can record from 100 to 10,000 g. Size is 2½" diameter by 7/16" thick. Weight is 3 oz. Engdahl Enterprises.
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MICROMINIATURE POTENTIOMETER. Addition or 50 ohm, 15K, 50K and 100K resistance values for Aceset microminiature, precision, wirewound potentiometers has been undertaken, increasing available values to thirteen, between 50 and 100,000 ohms. Electrical specifications are heat dissipation, 2 watts at 60°C; voltage breakdown, 1000 vdc; electrical angle, 325° nominal; resistance tolerance, ±10%; linearity ±5%. Ace Electronics Associates.
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HYDRAULIC PUMP. High temperature hydraulic pump, model 69W030, is a 3 gpm, 450°F, stainless steel and special alloy pump designed to operate in ambient temperatures as high as 700°F. New York Air Brake Co.
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1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125
126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150
151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175

• • Missile Literature

200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224

• • New Missile Products

225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245	246	247	248	249
250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	274
275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299

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MISSILE LITERATURE

SIZE 8 SERVOMOTOR. Design information on the smallest size 8 servomotor on the market is contained in data sheet #1366 issued by the Helipot Corporation.
Circle No. 200 on Subscriber Service Card.

INTEGRATING MAGNETIC AMPLIFIER. Two-page bulletin describing new #430 integrating magnetic amplifier for use in missile guidance and precision-control equipment. Amplifier operates from standard 115 v, 400 cps power supply and requires less than 3 watts. Completely self-contained, plug-in unit weighing less than nine ounces. Acromag, Inc.
Circle No. 201 on Subscriber Service Card.

PRECISION-ROLLED METAL STRIP. Designed to aid engineers' selection of proper metal strip for specific applications, booklet is an alphabetically-arranged catalog of electronic parts and components showing precision-rolled metals now being used. Precision-rolled strip comprises all metals rolled to thicknesses as thin as 0.0005" and/or high tolerances as close as ±0.0001". American Silver Co.
Circle No. 202 on Subscriber Service Card.

HIGH-TEMPERATURE EQUIPMENT. Product bulletin, MPB-32 has been issued by General Electric Co., describing successful operation of electronic equipment at ambient temperatures of –67°F to 750°F without the use of refrigerants.
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HYDRAULIC SERVO DRIVES. Bulletin features precision response to a small signal characteristic of servo hydraulics and electro-hydraulic systems. Based on theme "On yesterday's experience Vickers builds today and develops for tomorrow." Vickers, Inc.
Circle No. 204 on Subscriber Service Card.

MYLAR CAPACITOR. Bulletin contains engineering data and electrical characteristics for this type of non-hygroscopic polyester film capacitor. Pyramid Electric Co.
Circle No. 205 on Subscriber Service Card.

AUTOMATIC VOLTAGE REGULATORS. Bulletin S358-E describes line of instantaneous electronic automatic voltage regulators. Products feature all electronic operation, no moving parts, instantaneous correction, excellent regulation and stabilization and minimum waveform distortion. Twelve-page bulletin gives complete ratings, outline dimensions, features, and prices. Superior Electric Co.
Circle No. 206 on Subscriber Service Card.

THERMISTOR CIRCUITS. Fifteen different circuits are covered in this booklet, which gives specifications for nearly 400 different thermistors, including assemblies, matched pairs, beads, discs, washers, rods and probes. Includes description of basic thermistor properties and characteristics, with diagrams of typical applications. Catalog EMC-2 is available from Fenwal Electronics, Inc.
Circle No. 207 on Subscriber Service Card.

TACHOMETER TEST EQUIPMENT. Twelve-page engineering report describes test procedures and equipment used in determining stability, linearity and other characteristics of d.c. tachometer generators. Servo-Tek Product Co.
Circle No. 208 on Subscriber Service Card.

FREQUENCY ASSIGNMENT LISTS. Prepared semi-annually by the Federal Communications Commission, this list is now available to the communications industry through subscription. Electronic Industries Association.
Circle No. 209 on Subscriber Service Card.

MICROWAVE FILTERS. Two catalogs on microwave filters have been published, one listing a number of standard low-pass/high-pass filters of the block, tubular and shell types operating in ranges from 10 mc to 12,000 mc; and the other illustrating typical waveguide rf filters with very sharp cutoff and low insertion loss in the passband. Microphase Corp.
Circle No. 210 on Subscriber Service Card.

DECADE COUNTER TUBES. Technical booklet prompted by growing significance of cold cathode counter tubes in data processing, machine controls, nuclear and radiation measuring equipment, and X-ray controls. Eight-page brochure covers electrical characteristics and application data on the most popular types of counter tubes. Sylvania Electric Products, Inc.
Circle No. 211 on Subscriber Service Card.

PARTICLE ACCELERATORS. Two-color Brochure (Bulletin B) gives many known and potential applications of both Van de Graaff and linear accelerators, utilizing photos and line drawings to point up significant design and performance features. High Voltage Engineering Corp.
Circle No. 212 on Subscriber Service Card.

ULTRASONIC CLEANING. Illustrated booklet explains practical applications and basic principles of ultrasonic cleaning and also covers design of equipment. Discusses general system considerations, batch immersion, conveyor and multi-stage systems, and various transducer arrangements. Branson Ultrasonic Corp.
Circle No. 213 on Subscriber Service Card.

CONNECTORS. Forty-page catalog, completely revised, gives specifications, drawings, illustrations on miniature connectors. De-Jur-Amsco Corp.
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1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125
126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150
151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175

● ● Missile Literature

200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224

● ● New Missile Products

225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245	246	247	248	249
250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	274
275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299

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Today's increasingly stringent design requirements for low weight, maximum strength, high temperature components mean every ounce of material must efficiently perform its designed task. The uniform success of Narmco products in applications like these explains why more and more engineers are turning to Narmco when faced with a tough component design problem. They are finding that Narmco products help put ALL the material to work, by spreading the load and increasing rigidity... which means more strength... less weight... longer fatigue life... and greater economy...

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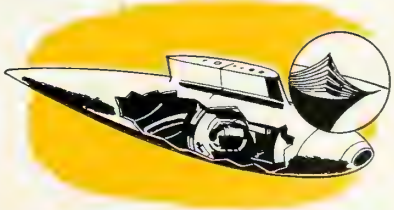
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BELL HELICOPTER engineers achieved weight savings ...fabrication economy... and longer fatigue life when they selected a laminated metal design for the XH-40 rotor blade, which is bonded with Narmco's Metlbond® 4021 system... distinguished for its high peel strength and outstanding resistance to fatigue. Exhaustive tests have shown that bonded rotor blades are able to meet demanding performance requirements under repeated flexural loads.



THIS "RUDDEVATOR"—a bonded sandwich structure—for the Boeing KC-135 jet tanker's flying boom required a structural adhesive capable of withstanding severe loads as well as enormous operational punishment. The solution: Narmtape® 102 system, a supported adhesive formulated with non-brittle constituents to provide unmatched fatigue resistance under highest stress and vibration.



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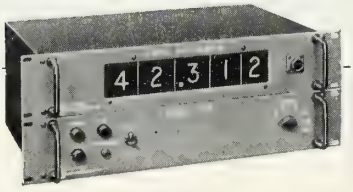
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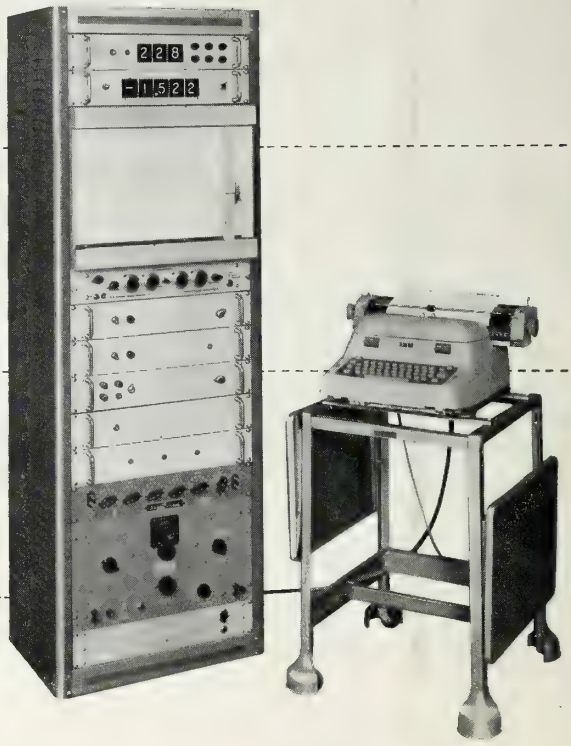


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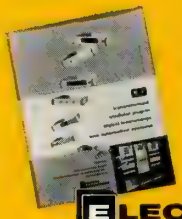
for measuring DC to 0.01%, AC to 0.1%, Ohms to 0.01%, DC ratios to 0.01% and AC ratios to 0.02%

Standard, off-the-shelf modules never become obsolete—provide maximum versatility. As needs change, simply regroup old modules or add new ones. Your system is always current at minimum cost and engineering. Internal construction is also modularized for ease of maintenance.

Fully transistorized circuits result in increased reliability, reduced power consumption, low heat dissipation, miniaturized packages, and eliminate radio noise and line transients.

Important new specifications—Wider, dynamic ranges cover all voltages from 100 microvolts to 1,000 volts; resistance from 10 milliohms to 10 megohms. Input power frequencies from 50 to 400 cycles. New balance logic speeds down ranging. Automatic AC ranging from 30 to 10,000 cycles. Use of transistors increases switch life by a factor of three.

Wide selection of input and output modules for operating printers, IBM punches, etc., can be accommodated without modifications. All contacts are accessible at rear panels with connectors. With plug-in modules, digitized data is provided in printed form, punched cards or tape without modification to basic measuring instruments.



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3794 Rosecrans Street
San Diego, California

JULY 21, 1958



missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

News and Business Edition

AN AMERICAN AVIATION PUBLICATION



Sequence of a typical photo reconnaissance mission with the Radioplane SD-1 drone

Eye in the Sky

SITUATION: *A range of hills screens enemy activities.*

TACTICAL PROBLEM: *What is on the other side of the hills?*

SOLUTION: *Aerial drone surveillance—puts an "eye" in the sky.*

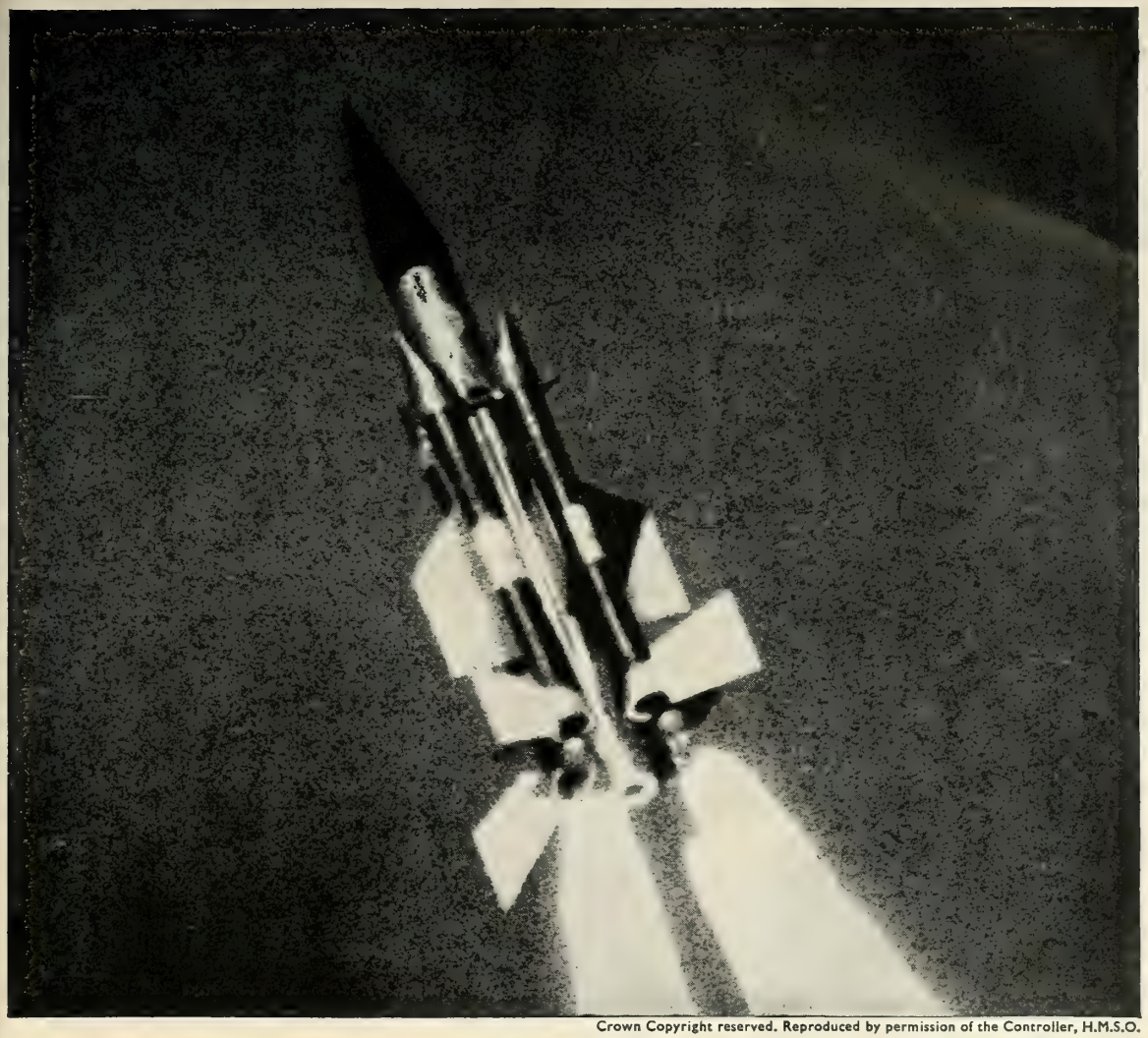
Radioplane, in conjunction with the U.S. Army Signal Corps, developed and is producing the SD-1 surveillance drone system. Highly mobile, the camera-carrying SD-1 may be zero-length ground launched in rough terrain from a camouflaged position and flown by remote control over enemy installations on photo reconnaissance missions. After the drone's camera has exposed its film by radio command over the target, the SD-1 is then flown to a pre-designated area for parachute recovery. The camera is removed, the film is processed, and prints are delivered to the requesting unit within minutes after the entire operation began and the mission is accomplished without risking a pilot's life or a large man-carrying aircraft.

The Signal Corps SD-1 surveillance drone system is another example of Radioplane's constant refinement of the art of producing radio-controlled drones. First to manufacture target drones exclusively for military use Radioplane has a world-wide field support organization with personnel qualified to assist in all phases of drone field activities.

RADIOPLANE

A Division of Northrop Aircraft, Inc.

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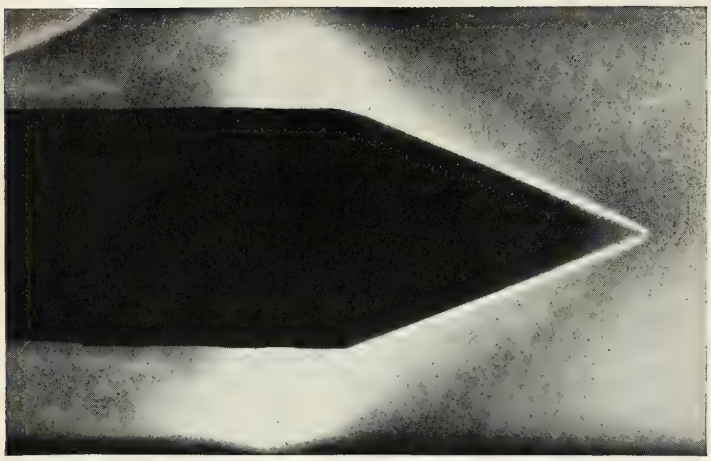
NOW—THUNDERBIRDS FOR THE R.A.F

The ENGLISH ELECTRIC Thunderbird, already in production for the Army, has now been ordered for the R.A.F. It is the only ground-to-air guided missile in production for both Services.

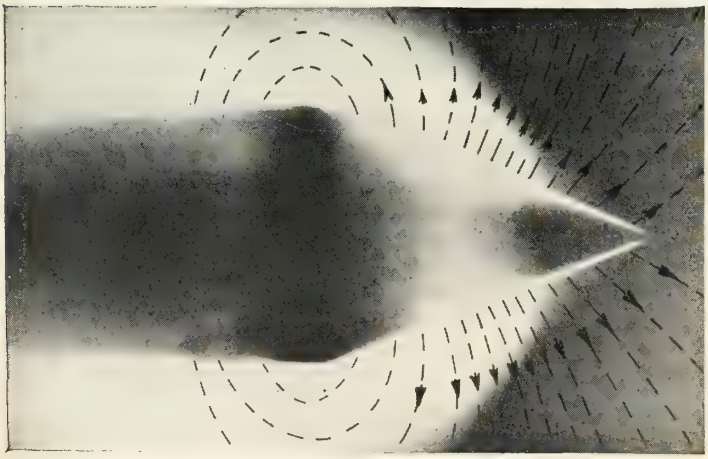
'ENGLISH ELECTRIC' guided weapons

THE ENGLISH ELECTRIC COMPANY LIMITED · GUIDED WEAPONS DIVISION: LUTON · STEVENAGE · WOOMERA

NEW LIGHT ON MHD*



NO MAGNETIC FIELD. This shock tube photograph, taken by emitted light only, shows the typical shock wave configuration formed by high-velocity gas flowing around a pointed cone.



WITH MAGNETIC FIELD. Here is shown the magnetohydrodynamic displacement of the shock wave. The magnetic field is caused by electric current flowing through a coil of wire within the cone. This experiment qualitatively demonstrates the interaction of a high-temperature gas with a magnetic field. This effect would be expected to produce drag and reduce heat transfer to the body.

The Avco Research Laboratory was founded a little more than three years ago for the purpose of examining high-temperature gas problems associated with ICBM re-entry. The success of this research led to the birth of a new corporate enterprise, Avco's Research and Advanced Development Division.

The Research Laboratory, now established as a separate Avco division, has expanded to embrace all aspects of physical gas dynamics. We are currently gravid with several embryonic projects which we anticipate will likewise grow into new corporate enterprises. Our work in the physics, aerodynamics and chemistry of high-temperature gases is growing in the following areas:

Magnetohydrodynamics—
Flight and industrial power-generation applications

Space flight—
Manned satellites
Electromagnetic propulsion

These developments have created a number of openings for physicists, aerodynamicists and physical chemists. If your background qualifies you to work in any of these areas, we would be pleased to hear from you.

Dr. Arthur Kantrowitz, Director
Avco Research Laboratory

P.S. A listing of laboratory research reports indicative of the scope and depth of our activities is available. Address your request: *Attention: Librarian, Avco Research Laboratory, 2385 Revere Beach Parkway, Everett, Massachusetts.*

***Magnetohydrodynamics,** the study of the dynamics of electrically conducting fluids interacting with magnetic fields.

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editorial viewpoint . . .

It seems that a candle has been brought out from under a bushel basket. The public is becoming interested in our missile programs. It was brought out in the July 14 edition of the WASHINGTON POST AND TIMES HERALD, which called attention to a situation and a basic fallacy that has long been apparent to those in the missile field.

For a long time now, the missile men have realized that there is a fallacy in publicizing the current ICBMs as weapons of massive retaliation for a sneak attack. With the flight time of an ICBM estimated at 30 minutes, it is folly to think that our ICBM bases would be in existence for the necessary two hours to fuel, check out, program and launch the *Atlas* . . . or the *Titan*.

In an editorial, the newspaper said: "The further development of missiles of the *Atlas* type is not promising. Before too much more is invested in this project, there ought to be an intensive re-appraisal of more promising systems, such as the relatively less vulnerable . . . submarine-launched *Polaris* missiles."

With the publication of this realistic viewpoint, the POST has focused attention upon a previously little-known situation. It is quite likely that millions of people in this country were blithely assuming that the operational status of *Atlas* would insure safety from sneak attacks. Examination of the pre-launch requirements of *Atlas* shows that this could not possibly be, unless by some fantastic stroke of stupidity, the Soviet Union did not choose to list our ICBM bases among the prime targets of its missiles.

The editorial in the POST is one sign that the public realizes that some of our missiles are not what they are cracked up to be. This public interest in missiles is good and it is important.

It is becoming known to John Q. Taxpayer that we have been hiding behind a Maginot Line of fixed-base IRBMs and ICBMs. We have even been foisting this concept upon our allies. With a more interested public watching, our missile planners are bound to pay attention in the future to sound and practical weapons systems.

contents

news

Reds Plan Satellite Launch from Antarctic
by Seabrook Hull 8
NACA To Boost Electronics Industry Dollars
by Donald E. Perry 10
A New Assessment of *Sputnik* Launchers' Power
by Alfred J. Zaehringer . 11
How A Manufacturer Banks on Research
by Raymond M. Nolan . 15
Powerful Vernier Engines
by Norman L. Baker ... 24
Army Engineers Get Go-Ahead on Missile Sites 29
Here's How *Gaslight* Looked to Observers 30
Army Unhappy Over *Nike-Zeus* Cut 32
Radford Supports House Reorganization Bill 33
Conferees Approve Space Agency Bill 33

columns

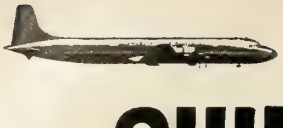
Missile Week 7
Missile Business 12
World Astronautics 22
Propulsion Engineering 27

departments

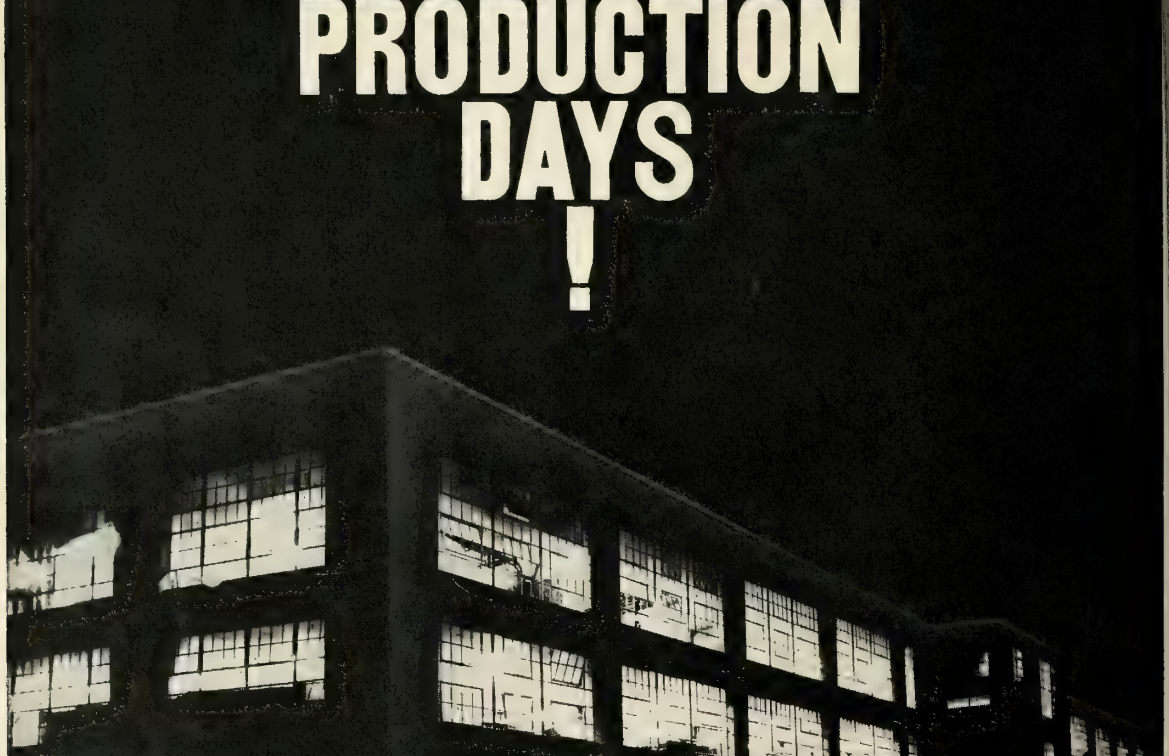
Industry Countdown 9
Contract Awards 12
Missile People 20

cover

Technician from Minneapolis-Honeywell's Ordnance Division assembles fuzing and arming device for ballistic missile warhead. See p. 15 for a report on the company's defense activities.



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An m/r staff report from WASHINGTON

• **HAVE GREENHOUSE, WILL TRAVEL** might well be the slogan for future space pilots. Not long ago, former Secretary of Defense Wilson had some unkind remarks about the AF's interest in why potatoes turned brown. The interest was very valid: One of the biggest problems in planning manned satellites or space travel is an adequate supply of breathable oxygen. Man breathes in oxygen and exhales carbon dioxide. Plants take in carbon dioxide and emit oxygen. Low forms of plant life, including potato sprouts, were, and probably are, an important part in basic research to develop such a regenerative environment for man in space.

• **PIED PIPER HAS A NEW NAME.** An AF witness told members of the Joint Committee on Atomic Energy that Pied Piper now is called SNAP (Secondary Nuclear Auxiliary Power). Which leads to the possible conclusion that nuclear power will be employed in a future reconnaissance satellite vehicle.

• **PENTAGON CORRIDORS CRACKLED** this week with speculations and claims of the service's cold war, limited war, and general war capabilities as the pro-Western regime in Iraq fell. All hands admitted the Navy carrier "Task Force" is the best way to show force, but Army and Air Force planners insist it will take more than that to fight even a limited war.

• **WHILE ADMITTING** it's psychological and deterrent value, both Army and Air Force spokesmen warn against putting all the nation's missile capability in a submarine—namely, the *Polaris*-carrying Fleet Ballistic Missile submarine. "Not enough punch," they argue. One AF representative pointed out the *Polaris* with its .1 megaton (correct) payload can't compare to the 20 megaton capability of a SAC bomber. Which probably was part of the argument that swayed Congress to up the ante for the B-52 program . . . or was it the 3 megaton payload on *Atlas* . . . or the 1 megaton payload on *Thor?*

• **DEVELOPMENT AND IMPLEMENTATION** of the *Talos* missile moved ahead as Vitro Laboratories got a Navy Board contract for systems engineering in conversion of three heavy cruisers to *Talos* and *Tartar* capability. In this respect Vitro is the Ramo-Wooldridge of the Navy.

• **THERE'S NO REST FOR THE WEARY** budget planners who sit in Washington trying to figure out how to make the financial pie go around. Example: the payroll for Army or Army-supported activities at Redstone Arsenal was over $95 million for the year ending July 1. Col. Keith T. O'Keefe, post commandant, said if rate continues upwards, the Redstone payroll will top $100 million by fiscal year 1959. The past year's spending set an all time high for the big ABMA installation.

• **ALL OF WHICH MEANS** that there probably will be efforts made to cut down on building of prototypes of other missiles in arsenals, and then having the job done again by the contractor with a resulting double production and tooling costs. That's the biggest objection to the *Jupiter*. According to one AF source, a *Jupiter* squadron will cost an estimated $122 million as compared with $57 million for a *Thor* squadron. *Thor* started and continues in the Douglas shop. Incidentally, the four-*Thor*-missile-squadron program is to cost $250 million and has been approved by the pentagon.

• **POPULAR NAME FOR CONVAIR-ASTRONAUTICS** new $40 million plant opened last week is "Dempseyland," in tribute to 36-year-old (former AF man) J. R. Dempsey, manager of that division of General Dynamics.

JULY 21, 1958
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missiles and rockets
MAGAZINE OF WORLD ASTRONAUTICS



BIG RUSSIAN BASE is Mirny, at bottom of the world. From this point . . . .

Reds Plan Satellite Launch From Antarctic

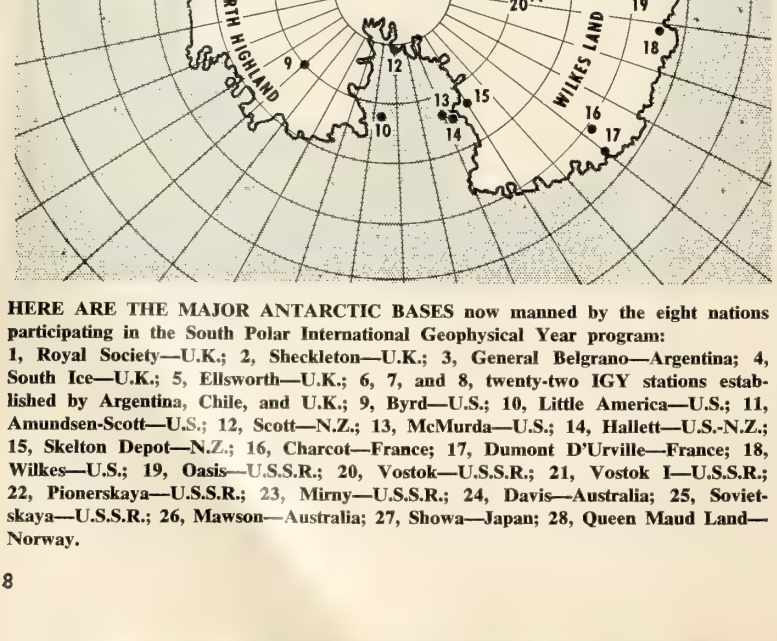
by Seabrook Hull

"We will eventually launch satellites from Mirny."

This statement was made by U.S.S.R. Academy of Sciences President Alexander Nesmyanov in reply to questions concerning Soviet rocket launching plans in Antarctica by a visiting American businessman.

Mirny is Russia's big—and permanent—base situated at Wilkes Land or, as Russian maps call it, the Pravda coast of Antarctica. Nesmyanov made his forecast of Russian Antarctica satellite launchings in the presence of three other top-ranking Soviet scientists, who enthusiastically supported his statement.

An important aspect of the Mirny base, in addition to its size, is its permanence. Unlike most of the other Antarctic bases set up by other countries, this one shows no signs of being abandoned at the end of the IGY. In a word, the Russians have moved into Antarctica to stay, and if Nesmyanov's words are any indication of the future, the Reds are establishing major missile-handling and launching capabilities.



HERE ARE THE MAJOR ANTARCTIC BASES now manned by the eight nations participating in the South Polar International Geophysical Year program: **1, Royal Society—U.K.; 2, Sheckleton—U.K.; 3, General Belgrano—Argentina; 4, South Ice—U.K.; 5, Ellsworth—U.K.; 6, 7, and 8, twenty-two IGY stations established by Argentina, Chile, and U.K.; 9, Byrd—U.S.; 10, Little America—U.S.; 11, Amundsen-Scott—U.S.; 12, Scott—N.Z.; 13, McMurda—U.S.; 14, Hallett—U.S.-N.Z.; 15, Skelton Depot—N.Z.; 16, Charcot—France; 17, Dumont D'Urville—France; 18, Wilkes—U.S.; 19, Oasis—U.S.S.R.; 20, Vostok—U.S.S.R.; 21, Vostok I—U.S.S.R.; 22, Pionerskaya—U.S.S.R.; 23, Mirny—U.S.S.R.; 24, Davis—Australia; 25, Sovietskaya—U.S.S.R.; 26, Mawson—Australia; 27, Showa—Japan; 28, Queen Maud Land—Norway.**

The Antarctic, in one sense, may be destined to become Russia's answer to the U.S. Strategic Air Command bases that now ring Russia, Europe, Africa and Asia, as well as in the U.S. It will provide her with a landing or launching site for full-range tests of her skip bombers, and poses a deadly threat to the U.S. from her unguarded south.

Once it's aloft, it doesn't really matter where a satellite was launched from, since it circumnavigates the globe anyhow. However, what is significant is the size and complexity of rocket-launching and support facilities that are required to place a satellite in orbit and the fact that Russia's number one scientist says these are being established in Antarctica.

The same base that can launch satellites can also launch 10,000-mile range ballistic rockets and 12,000-mile-an-hour rocket-boosted skip bombers, or provide landing facilities for them when fired from the Russian homeland.

From a strategic point of view, a Russian ballistic missile base on the South Polar continent will outflank North American defenses, virtually all of which are oriented to the North—facing Russia over the Arctic.

And even though the present DEW line, the mid-Canada line and the Pine Tree line are limited to intercept-detection of vehicles traveling at under Mach 3.0, when BMEWS (Ballistic Missile Early Warning System) is installed, it will utilize much of the communications structure of DEW line, etc., and,

according to present plans, it too will be facing north.

Advanced Research Projects Agency has ordered construction of special, giant radar scanners in the southern United States in order to be able to track satellites, even though they are not visible and are not transmitting tell-tale radio signals. However, these could scarcely be used to detect Intercontinental Ballistic Missiles and activate in-time defenses—even assuming there were any that could be fired southward.

The Russian move in Antarctica must almost inevitably require that the U.S. install anti-ICBM systems in the southern U.S., but also strategically beyond U.S. borders in the Caribbean and on the South American continent. The route from Mirny to the continental U.S. extends roughly over the South Pole and South American for a distance of 10,000-to-12,000 miles. Facilities in Antarctica to detect launchings might also be necessary.

Russia has previously announced that she will launch rockets in support of the International Geophysical Year from Mirny (66° 35′ ss, 93° e.), Russia and the Arctic. Original plans called for launching 30 rockets from Antarctica during the IGY. Even these upper air research rockets must require considerable in the way of launching facilities if altitude and payload are any indication. On February 21, the Russians fired an upper air research rocket to an altitude of 264 miles with an instrument payload of 3,344 pounds. It was this flight, incidentally, that first discovered the electron (X-ray) layer around the earth, later also discovered by Explorer III. At that altitude, the Russians reported an electron concentration of one million per cubic centimeter.

The only published reports of Russian IGY rocket firings in the Antarctic have been of shipboard launchings from the diesel-electric ship, Ob'.

Russia now has seven bases in Antarctica: Mirny, Pionerskaya, Vostok-I, Oazis, Komsomol'skaya, Vostok and Sovetskaya. Only Vostok-I is officially listed as "temporary." Since February 13, 1956, when the Russians landed at Mirny, a large permanent base has been constructed—replete with Persian carpets for the floors, central steam heating plant, mechanized land transport, and both aircraft and helicopters. Originally 20 basic buildings were put in place, including special magnetic, seismic and aerological centers; geophysical, geological, glaciological, gravimetric, aerophotogrammetric and other laboratories. Both men and women are stationed at Mirny. Listed as in charge of Russia's Antarctic expedition is Ye. Tolstikov.

industry countdown

• **Discount reports of a possible merger** of Thiokol Chemical with another company. Thiokol does need working capital, but is right now finalizing plans for a small additional stock issue "so as not to dilute present issue too much," plus a long term loan . . . **Reports are circulating that** *Minuteman* **propulsion system contracts** are in final stage, with Aerojet-General, assisted by Thiokol, responsible for first stage engine; Aerojet alone, second stage; and Aerojet assisted by Allegany Ballistics Laboratory, third stage. Thiokol denies any knowledge of this . . . **More reports** that a contract will be issued to develop wholly new propellant for *Polaris,* perhaps a composite double-base by ABL.

• **Lockheed says** *Polaris* **is a year ahead** with delivery to fleet possible in 1959 instead of 1960 . . . **Donald W. Douglas, Jr.,** speaking before L.A. Transportation Club, said that the most important space-age problem today is development of propulsion systems with 10-to-100 times present thrusts . . . **Curtiss-Wright Chairman & President** Roy T. Hurley forecasts no major economic changes in aircraft industry in next six months, but major technical changes due to new weapons requirements.

• **The Budd Co. will research** non-destructive testing of solid propellants for Thiokol-Utah . . . **Northrop Aircraft will** participate in construction of the operational *Snark* base at Presque Isle, Me. . . . **Construction of first** *Titan* **ICBM launching pad** has been started at the new Pacific Missile Test Range . . . **Corps of Engineers** Maj. Gen. W. K. Wilson says 25-to-30% of Corps' constructions work is now devoted to missile sites compared to 15% in 1957 . . . **Ramo-Wooldridge** V.P. Burton F. Miller, at IAS L.A. meeting, said short-lived satellite vehicles may be used to improve air-ground communications and air traffic control.

• **AEC plans to test Kiwi-A** reactor for *Rover* after August 1, probably in November; AEC deputy chief Aircraft Reactors Branch says nuclear rocket would probably be needed to put 20,000 pounds or more payload in space . . . **Japan's Mitsubishi Electric Co. will build** Swiss Oerlikon anti-aircraft missile under license . . . **Sweden has ordered** substantial number of French SS-10 anti-tank missiles . . . **Joint U.K.-Australian** missile test program is scheduled for another five years . . **NAA Missile div. has received** two Army contracts to study simulated micrometeorites, and interaction of surface materials and high-temperature boundary layers.

• **On Capitol Hill,** Senate Small Business Procurement Subcommittee has ordered a new investigation of Pentagon procurement policies; hearings to start July 22 and run three days—Committee's concerned with decline of small business participation in government prime contracts . . . **Bill to indemnify government contractors** in unusually hazardous work for up to $300 million has been dropped for this year.

• **Air Force is starting** program to broaden its research base and to improve technical education of its officers . . . **L.A. Chamber of Commerce claims** military procurement policy favoring areas with labor surplus unnecessarily penalizes L.A. for its success . . . **California considering** holding International Space Age Exposition in 1962 and establishment of permanent space-age museum at Sacramento.

• **Lockheed Missile Systems Div. plans** to double size of its space communications lab with completion of 8,000-sq.ft. addition in mid-August . . . **AC Spark Plug will build** West Coast headquarters building in L.A. . . . **Work has started** on $1-million engineering and production center for R-W subsidiary Pacific Semiconductors, Inc., at Redondo Beach, Calif. . . . **Marquardt Aircraft Co. is spending** $1.5 million to double size of its Ogden, Utah, Bomarc engine plant to 250,000 sq.ft. . . . **AF Air Training Command** will give *Atlas, Titan* and *Thor* training at Kessler AFB, Miss.; Chanute AFB, Ill.; Sheppard AFB, Texas . . . **Magnavox Co. has formed** Magnavox Astro-Physics Laboratories, Inc., Rochester, N.Y.

• **Convair-Astronautics** formally opened its new $40-million 1,220 million sq.ft. *Atlas* production plant at Kearny Mesa, July 12 . . . **Aeronca Manufacturing Corp.** renamed its Baltimore facility as Baltimore Div., where Aeronca does electronics work, particularly computers, logger, comparators.

NACA to Boost Electronics Industry Dollars

by Donald E. Perry

MOFFETT FIELD—The electronics industry is scheduled to get a healthy boost when the national Advisory Committee for Aeronautics becomes the nation's civil space agency.

During last week's triennial inspection of Ames Aeronautical Laboratory, NACA officials made it clear that the new national aeronautics and space administration, now lacking an electronics capability, would utilize the research potentials of industry rather than build extensive facilities. NASA will have a first year budget of approximately $300 million, and some believe it will approximate $1 billion annually within five years. A healthy percentage of the budget will go to electronics.

The inspection, attended by more than 500 leaders in the military services, the aircraft, missile, space craft, and related industries, was geared to explain NACA's present research activities in space and its capabilities to become the nucleus of the civil space agency.

Expansion plans of NASA, it was learned, will include construction of a multi-million dollar electronics data reduction center in the Washington, D.C., area; acquisition of an equatorial satellite launching site; expansion of launch complexes at Wallops Island, Virginia and enlargement of existing facilities at Ames, Cleveland, and Langley Field.

At Ames, nearly $2 million has been programmed for construction of a 12 x 12-inch hypersonic helium tunnel for the study of flow phenomena of missiles in the 12-20 Mach range. Another $1.5 million is programmed for expansion of Ames' hypervelocity research laboratory, which will be used to study the basic properties of high-temperatures gases. Two IRBM-type launching complexes will be built at Wallops.

• **Research work**—The inspection pointed up these research activities in space technology by NACA:

Propulsion: Lewis Flight Propulsion Laboratory's work on nuclear rockets include nozzle design, and selection of materials and design to minimize weight. In chemical rockets, an injection method to improve performance, cooling, weight, combustion stability, and fabrication is being researched. In the field of nuclear-electric propulsion, NACA is researching lighter weight conversion of thermal energy into electrical energy, and new cooling methods for the magnetic field electrodes and energy sources.

• **Entry research**—NACA has developed an atmosphere-entry simulator to simulate the entry of ballistic missiles, satellites, and space craft. Models are launched by a high-velocity helium "gun." In tests of copper, which was used to absorb the heat associated with the simulated atmosphere entry, researchers found the metal to be considerably altered by flight. Small craters were observed in the metal after firing, and NACA believes they were caused by small particles of dust in the air stream.

Another research development is a ballistic range, which is being used to take a close look at the effects of flight at selected pressures or altitudes. By testing scale models at the true flight speeds in air at appropriate pressures, the aerodynamic heating and forces encountered by actual missiles and space vehicles will be duplicated. Models are shot at a speed of 16,000 mph into a 500-foot-long pressurized tank.

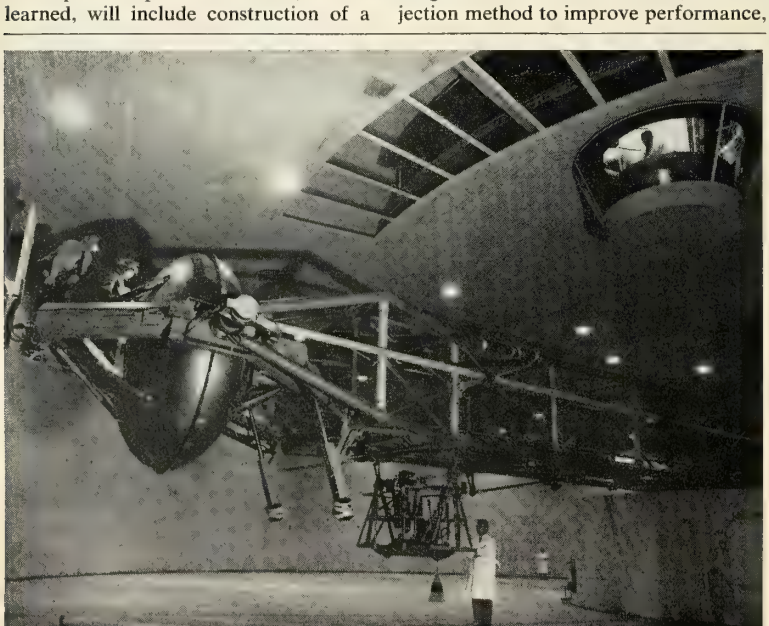
• **Satellites**—NACA had developed extremely lightweight inflatable satellites made of micro-thin plastic covered with aluminum foil. They will be used as radar targets, and for measuring air density and other characteristics of space.

The satellites, including 30 inch and 12-foot spheres, and a 12-foot corner reflector, will be propelled into space in a deflated condition, ejected into orbit and automatically inflated by a nitrogen gas cartridge.

• **Space craft flight research**—NACA is evaluating relative merits of a variety of promising materials. In operation are several high-temperature air jets that duplicate high speed, high temperature environment.

Materials being tested include zirconium dioxide, crystalline glass, graphite, copper, fibreglass and plastics.

• **Space craft piloting problems**—Research is being made in five problem areas: reduced damping; large and rapid changes in dynamic air pressure; flight reaction controls; interaction between space craft controls; and better programming of information to the pilot.



THE WORLD'S LARGEST human centrifuge at the Naval Air Development Center, Johnsville, Pa., is a keystone in the training of pilots, both from industry and the military, who will fly the nation's first space craft. The program is a joint operation of the Navy, Air Force, NACA, and North American Aviation Corp., manufacturer of the X-15. The first press demonstration was held last week. Scotty Crossfield of North American entered the testing operation, during which the centrifuge produced acceleration and gravity forces equal to those which will be experienced on the X-15 flight into space and re-entry, presently scheduled for early next year. The gondola is equipped with an actual X-15 control panel, and is flown by the pilot in response to signals from an analog computer. Centrifuge flights also permit placement studies of instruments and controls.

German Returnees Sketch Red IRBM Power Unit

by Alfred J. Zaehringer

EVEN THOUGH THE USSR has not shown its operational IRBM, the T-2, or its *Sputnik* launcher, a glimpse behind the ballistic iron curtain has been provided by the German rocket "collectives" which worked for the Reds from the end of World War II to 1950.

So far, the Russians have shown off only obsolete long-range weapons. Notable among these is the T-1 medium range rocket, a redesigned V-2 that is in the *Redstone* class.

• **Soviet goal**—Using the German accounts and coupling this with the view given during the last Moscow parade, the Soviets' immediate goal was to standardize on propellants and count on performance gains through high thrust rocket motors, high pressure operation, simplicity of design, and improved guidance techniques.

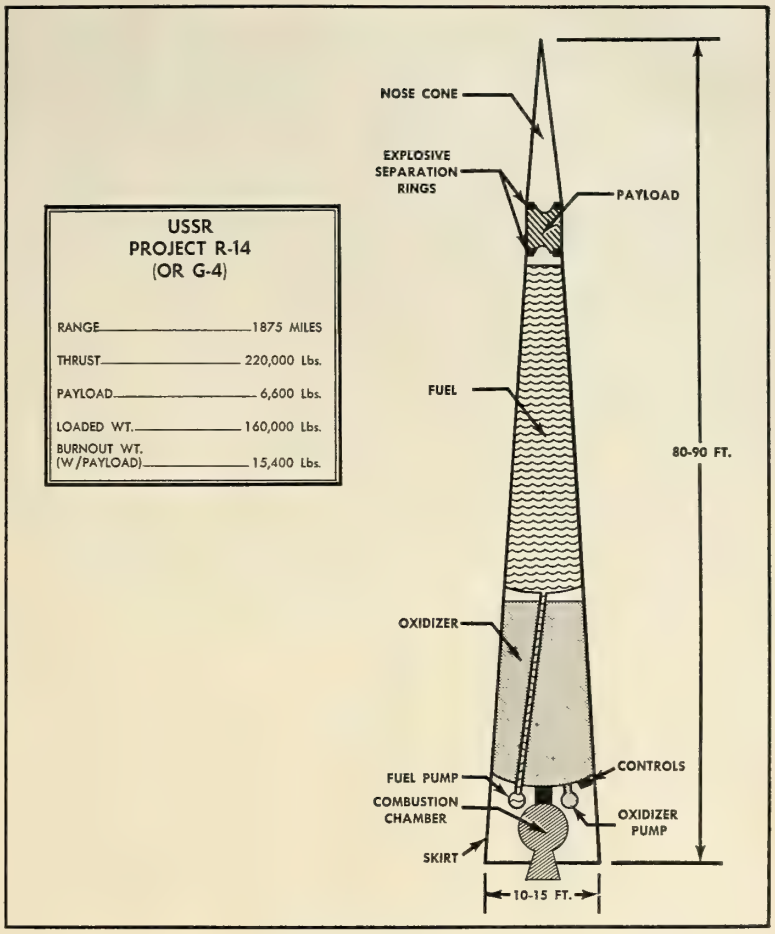
For this reason, emphasis was placed on LOX as the oxidizer and kerosene or watered alcohol as the fuel. Some work was also done on acid systems. Higher energy or "exotic" propellants were left for the laboratory.

What may be the prototype for the T-2 IRBM or the *Sputnik* vehicle was the German rocket collective study program known as Project R-14 (or G-4). This was to be an IRBM of 1,875 miles range and carrying a payload of 6,600 lb. Thrust of 220,000 lb. (a single 100 metric ton rocket engine) was generated by the combustion of standard propellants at a pressure of 60 atmospheres (900 psi).

The aim was eventually to operate at even higher pressures. The 60-atm system was to operate via a two-stage turbopump, while higher pressures would be developed by a three-stage system. Cooling for the nozzle came directly from the fuel tank. The combustion chamber itself was cooled by fuel from the first stage pump, while the chamber head was cooled by the output of the second stage pump.

Other performance gains were to come from a radical shaving of weights. Integral tanks were selected, and the design studies showed that it was possible to build a ballistic rocket with a burnout weight of 10% of the launching weight. Moreover, the payload fraction of the empty weight was to be 40%.

Initial guidance was to be via a beam rider system. The warhead was to be separated by explosive rings and solid propellant rockets of high thrust and short burning time. Accuracy of placing the 6,600 lb. warhead on target was to be 1% of the range and azimuth.



• **Design operational**—It is believed that the design studies were frozen around 1950-1952. By this time the Germans had terminated their work and the Soviets were completely on their own. This gave the Reds some five years to build and begin testing.

By 1957, the T-2 IRBM had become operational and the *Sputnik* launchings were ready.

However, at the time of design freeze, warhead weights were large (viz., the 3 metric ton payload weight of the R-14 Project). It now means that the Russians can fire large hydrogen weapons over most of Europe. More significantly, the R-14 project has given us a closer "guesstimate" of what the T-3 ICBM or the *Sputnik* vehicles were like.

It is quite probable that the T-3 ICBM uses the T-2 as the upper stage, and that at least a two stage vehicle is involved. The T-3 would more probably look like the Martin *Titan* than the single stage Convair *Atlas*, and would be a multi-purpose weapon from the standpoint of production.

• **Future estimates**—Since the T-2 engine is rated at about 220,000 lb. thrust, the conservative estimates are that the T-3 would have to put out 3 to 5 times the thrust. Whether this is being done with a single large engine (at near 1 million pounds of thrust), or whether a bank of T-2 engines are being used is problematical.

First stage thrust for *Sputniks* I and II have been estimated at about 466,400 lb. by rocket experts Engel and Boedewadt. One may speculate whether the first two Russian satellites were launched by a souped-up T-2 IRBM or a modified T-3 ICBM.



missile business

by Seabrook Hull

Several new philosophies in missile system planning and procurement are becoming evident. They will have a material impact on "who" gets "how much business" and how that business will be conducted. Watch these trends. They will help you in planning your sales campaigns.

Boeing Airplane Company has been given the *Dyna-Soar* program. There is very strong indication that this is true, and that the Martin-Bell team is in solely to "keep them (Boeing) moving and on their toes." This could mean that the Air Force is using the competitive study contract system primarily as a psychological prod. This may be all well and good from the point of view of getting top "running scared" performance out of the selectee, but this kind of predetermination can cause those companies on the team "that never had a chance anyhow" to waste a lot of time, money and manpower. We will follow this situation closely.

Efforts are being made to rationalize missile families, so as to eliminate duplication of and to fill gaps in capabilities. For example, the official Army view is that *Sergeant* is the replacement for both *Corporal* and *Redstone,* and that *Pershing* extends the Army's missile range. This makes *Sergeant* an over-200-mile bird; *Pershing,* over 500. It also emphasizes a problem with the smaller solid propellant missiles, namely, that they have a limited flexibility of range. In this connection, Army is designing and developing a missile with a range between *Little John* and *Honest John,* and another to fill the gap between *Honest John* and *Lacrosse.*

Foreign missiles for U.S. forces under the Mutual Weapons Development Program is another trend that may be about to pick up steam. Pending delivery of the *Dart,* U.S. Seventh Army is already using the French *SS-10* anti-tank missile for training and evaluation. Army is now known to be considering a British missile for use with U.S. forces. And, there are unconfirmable reports of possible closer cooperation between the U.S. and Britain in the design, development and production of IRBM-type missiles.

These foreign reports emphasize the business importance of keeping close tabs on European developments in the whole field of rocket and missile technology. If possible, a full-time technical scout should be maintained abroad, or at least, the retaining of a part-time service.

Another massive merger appears to be under way which could have a major effect on the missile business. The Dutch-owned international giant, Philips Lamp, is reported to be about to merge its more-or-less-controlled subsidiaries: Philips Electronics, Consolidated Electronics Industries and Central Public Utilities into a single corporation. This corporation could be so devised as to start out life with $100-million worth of liquid assets.

contract awards

NAVY

By Purchasing Office:

Epsco, Inc. received $121,320 for data handling system.

Elgin National Watch Co., West Coast Micronics Div., received $57,051 for safety arming devices.

Detroit Controls, Div. of American-Standard, received $25,591 for controls.

General Electric Co. received $1,477,820 for components of MA-1 compass systems.

Goodyear Aircraft Corp. received $62,934 for study for anti-submarine defense.

By Bureau of Ordnance:

Coates Electric Mfg. Co. received $75,-230 for 14 missile altitude and velocity simulators; 13 pneumatic missile test sets.

Convair, a div. of General Dynamics Corp., received $107,104 for *Terrier* guided missile test equipment.

By Office of Naval Research:

Leland Stanford Jr. University received $35,000 for research in electron microspectroscopy of macromolecules.

University of California received $50,000 for research in the nature and location of corrosion fatigue attack, and $60,000 for research on the effects of high pressure and temperature on transformations and constructions of metal and inorganic solid systems.

General Mills, Inc. received $34,182 for research on thermoelectric properties of semiconducting compounds.

Boston University received $29,860 for research in the effects of changes in communication patterns.

Manufacturing Laboratories Inc. received $60,000 for research on lattice stability of metallic phases.

Colorado School of Mines, Research Foundation, Inc., received $52,200 for research on the properties of dislocations in body-centered cubic metals.

Mass. Institute of Technology received $75,000 for research on the structure of liquid metals and alloys.

University of California received $368,285 for research on the radio-frequency spectrum of galactic and extra-galactic sources.

Manson Laboratories Inc. received $74,955 for research on the development and fabrication of two prototype alkali vapor resonance magnetrometers.

General Electric Co. received $34,085 for research on low temperature brittleness of refractory metals, and $30,794 for research on the nuclear magnetic resonance study of metals and alloys.

Sylvania Electric Products, Inc. received $35,147 for research on intergranular fracture of metals at elevated temperatures.

Stanford Research Institute received $38,854 for research on preparation and properties of oxide single crystals.

Armour Research Foundation of Illinois Institute of Technology received $30,000 for research on mechanism of stress-corrosion embrittlement.

Franklin Institute of the University of Pa. received $61,530 for research on solid solution hardening.

Rias Inc. received $30,840 for investigation of bulk and surface defects in cold-worked metals.

Leland Stanford Jr. University received $27,986 for research on the formation of intermediate alloy phases by diffusion processes.

Westinghouse Electric Corp. received $110,000 for research on collision processes relating to the ionosphere.

Mass. Institute of Technology received $100,000 for studies leading to the growing of single crystals, and $95,000 for investigation of the thermoelectric and other physical properties of a wide variety of binary and other compounds.

Duke University received $25,000 for research on nuclear magnetic resonance at low temperatures.

University of Cincinnati received $36,-830 for research on Me-ZR-Ti-O phase diagrams.

Winzen Research Inc. received $32,315 for research on Project Skyhook.



Blinding Speed:

Speed so great that existing control systems were incapable of directing its flight path . . . so great that newer, more compact, more accurate, virtually automatic control systems were developed to guide the B-58, America's first and only bomber capable of sustained supersonic flight.

Today, this is an outstanding fact of the B-58 . . . sustained supersonic flight, rivaled only by its *growth potential*. This means that tomorrow, it will go even further.

Growth potential in the airplane results from growth potential for the individual engineer. This, and the strong challenge to his creative ability, are integral parts of the new concept in engineering organization at Convair-Fort Worth that has produced such a world challenging weapon.

If your ambitions call for a position that provides such growth potential for you, send a confidential resume of your training and experience for consideration by engineers in the area most suited to your qualifications. For personalized handling, address your inquiry to Box *748M*.

CONVAIR FORT WORTH

FORT WORTH, TEXAS

CONVAIR IS A DIVISION OF GENERAL DYNAMICS CORPORATION

Kingfisher Target Missile Delivered to Army

First of a series of Q-5 *Kingfisher* recoverable ramjet target missiles has been turned over to the Army under a $7.5-million contract to Lockheed Aircraft Corp.'s Missile Systems division. The *Kingfisher* is the latest development in the Q-5 missile program. It was previously under an Air Force contract with Army participation. The Q-5 family is a development of the Lockheed X-7 ramjet test vehicle.

The *Kingfisher* is equipped with a firing-error indicator electronic scoreboard which records and transmits firing accuracy information on hits and misses.

The 38-foot bird weighs in at about 8,000 pounds when ready for flight, and has a wing span of 10 feet, with a 20 inch diameter. Launched from an Air Force B-50, it is propelled to speed by underwing rocket boosters until its Marquardt ramjet takes over. The Army will use it to test anti-aircraft missiles at White Sands.

$65 Million Contract Granted for *Snarks*

Three contracts totaling over $65 million have been awarded to Northrop Aircraft by the Air Materiel Command.

The contracts involve the *Snark* long-range intercontinental air-breathing missile, and break down as follows: $37.9 million for 16 *Snarks;* $18.7 million for *Snark* development tests; $8.7 million for ground support equipment.

Chemical Firm Develops New Plastic for Missiles

A new plastic for missile and rocket parts, said to be able to withstand up to 4,500°F, has been developed by Reichold Chemicals, Inc.

Reinforced with glass cloth or asbestos, the resin can be used for nose cone sections, skin strengtheners, internal hoops, electronic equipment mountings and other parts, the company reports.

Laminated parts made from the new phenolic resin (Plyophen 5900) can take heat of 500°F for 100 hours and longer, and will successfully withstand the maximum 4,500° for short periods.

Other properties claimed by the company are: exceptionally high strength at extreme temperatures; low moisture absorption; good insulation properties and good resistance to organic solvents, weak inorganic acids, hydraulic aircraft oil, de-icing fluids and hot gas erosion.

. . . contracts

AIR FORCE

By AFFTC, ARDC, Edwards AFB:

C. A. Sheldon Electric Co. received $50,615 for space time system for timing use of sled on experimental track.

Allied Chemical & Dye Corp., General Chemical Div., received $28,000 for engineering study of reaction of fluorine and metals.

By Cambridge Research Center, ARDC:

Ball Brothers Research Corp. received money for design and construction of a rocket borne monochromatic camera.

Research Technology Associates, Inc. received $38,783 for study of electron and ion beams under outer space conditions.

General Mills, Inc. received $63,749 for research on balloon barrier materials and balloon structural members.

Ohio State University Research Foundation received $25,000 for study of parametric amplification.

Hughes Aircraft Co. received $89,099 for study of control of electromagnetic radiation from aircraft and space vehicles.

Sylvania Electric Products, Inc. received $74,447 for investigation of factors affecting microwave electrical breakdown and transmission near missile antennas.

Melpar, Inc. received $44,771 for air electromechanically trough-guide scannable antenna.

Radiation, Inc. received $40,000 for research directed toward the accomplishment of absolute low-level beta analysis of samples for strontium 90 and lead 210.

By HQ AFMTC, ARDC, Patrick AFB:

Hallamore Electronics Co. received $118,780 for racks, discriminator.

Nems-Clarke Co. received $46,634 for polarization Diversity combiner.

Dynatronics, Inc. received $111,300 for cotar remote positioning modification kit and polarization diversity modification kits for TLM-18 antennae.

Cubic Corp. received $175,679 for increase in funds.

Radiation, Inc. received $48,000 for increase of funds.

Cubic Corp. received $158,808 for laboratory study and narrow band correlation detection unit for Cotar.

Dynatronics Corp. received $44,151 for airborne telemetry test and calibration racks.

Lenkurt Electric Co., Inc. received $136,446 for real time data transmission system.

By HQ AFOSR, ARDC:

University of Chicago received $247,946 for research on nuclear interactions in cosmic rays.

University of Washington received $30,000 for "boron and silicon chemistry."

University of Illinois received $25,000 for continuation of research on diffusion in metals.

University of Texas received $74,502 for continuation of research on "gas-phase and surface reactions of hydrocarbons at moderately high temperatures."

Mass. Institute of Technology received $48,550 for "aerothermoelasticity."

University of Rochester received $245,060 for research on optical and electrical properties of solids.

Polytechnic Institute of Brooklyn received $100,000 for continuation of research on "electromagnetic theory and information processes."

Harvard College received $78,144 for research on combustion aerodynamics.

Aeronutronic Systems, Inc. received $135,549 for a study of hypervelocity particle effects.

Sunstrand Turbo, a div. of Sunstrand Machine Tool Co., received $41,969 for research program on rational scaling procedures for liquid fuel rocket engines.

AVCO Mfg. Corp., AVCO Research Laboratory Div., received $151,011 for research on "basic studies in magnetohydrodynamics."

University of Southern California received $26,300 for research on "thin liquid films."

Mass. Institute of Technology received $107,350 for research on "heat transfer characteristics of diffusion boundary layers."

Princeton University received $87,598 for research on the ignition of solid propellants.

University of Maryland received $37,700 for research on reports concerning "intermittent and non-linear processes in turbulent flows."

Princeton University received $242,550 for research on combustion processes in liquid propellant rocket engines.

University of Illinois received $91,858 for a study of the crystallography and morphology of martensites, and of the properties and dislocations in crystals.

ARMY

By Engineer District, Pittsburgh, Corps of Engineers:

Drost-Sanford Construction Co. received $253,375 for construction of *Nike* support facilities for Cleveland defense area.

By Engineer Div., New England, Corps of Engineers:

Emerson & Cuming, Inc. received $31,260 for conducting research and investigations directed toward the development and evaluation of an inorganic ultra high temperature dielectric material.

Jansky & Bailey, Inc., received $121,492 for conducting interference control studies, and obtaining data for electronic systems.

Grinnell Co., Inc. received $35,947 for nozzle and detector head assembly.

General Electric Co. received $540,000 for two development models of range height indicator.

By Purchasing and Contracting Division, White Sands:

Dorsett Labs. Inc. received $97,550 for telemetry system.

By Ordnance Missile Command, Redstone Arsenal:

Atlantic Design Co. received $71,968 for 20,800 manhours of maintenance for ballistic missile systems and equipment.

Consolidated Avionics Corp. received $30,504 for developing criteria and reduction in checking out missile systems, and utilizing the criteria developed for making final designs of such equipment.

By Signal Supply Agency:

University of Michigan received $65,000 for research studies directed toward development of "an algebra for automata."

Purdue Research Foundation received $97,245 for research work to be employed in a silicon crystal-perfection study.

General Electronics Labs., Inc. received $44,387 for research and development work leading to the design and fabrication of experimental model duplex rhombic antenna.

Westinghouse Electric Corp. received $89,983 for research work leading to the development of a high temperature match box receiving tube.

University of Akron received $78,000 for studies of condensation polymers such as nylon, mylar and the siliconer.

Sperry Gyroscope Co., Div. of Sperry Rand Corp., received $5,201,744 for equipment plan, missile impact locators.

University of Pa. received $45,806 for experimental and research work for microwave crystal deterioration study.

Battelle Memorial Institute received $299,770 for additional studies, investigations, tests and materials covering standardization of electronic component parts and materials.

Arthur E. Magher Co., Inc. received $208,927 for rehabilitation of environmental chambers.

North American Philips Co., Inc. received $82,470 for engineering test models of hexagonal magnetic materials.

University of Wisconsin received $80,000 for research study of micrometeorology to determine experiments, means, and concepts to increase basic knowledge of aerodynamic processes in the lower atmosphere.

By Engineer District, Jacksonville, Corps of Engineers:

Maurice H. Connell & Associates, Inc. received $85,000 for design of complex 30 (Pershing) facilities, ABMA.

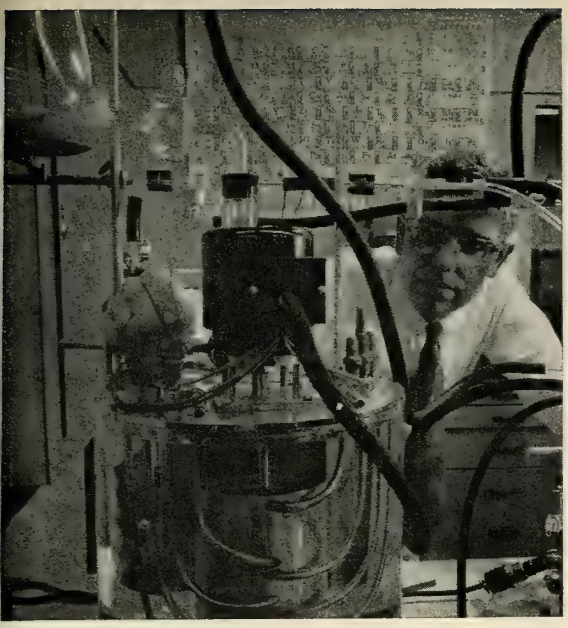
By Electronic Proving Ground Proc. Office:

Motorola Inc. received $4,186,840 for prototype electronic warfare system.

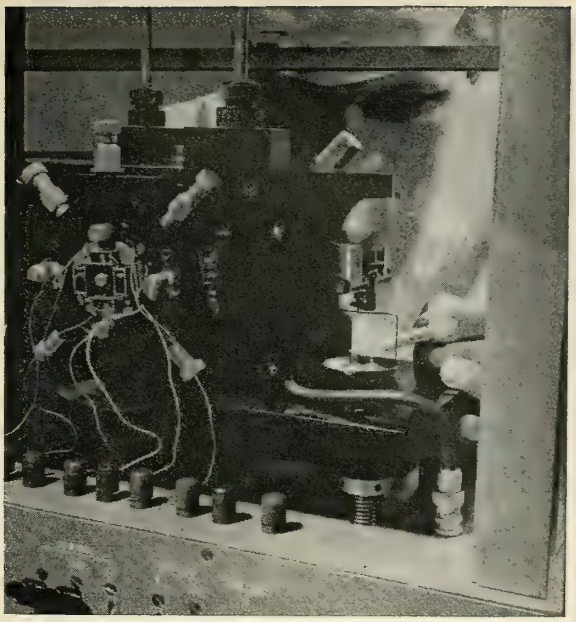
By New York Ordnance District:

Belock Instrument Corp. received $59,997 for design, engineering and fabrication for a guidance and control system.

Union Carbide Development Co., Div. of Union Carbide Corp., received $68,377 for a research program of evaluation of performance of structural metals.



MATERIAL LABORATORY is scene for testing gas solubility of flotation fluid for new type liquid-floated gyroscope.



M-H TORQUE BALANCE DEVICE used to calibrate microsyns. It measures torques as low as one eight-billionth of a lb.

Minneapolis-Honeywell:

How A Manufacturer Banks on Research

by Raymond M. Nolan

Not many companies today look to the poorhouse as the key to their future—but Minneapolis Honeywell is banking on just such a thing. Its Honeywell Research Center is located in a former county poorhouse on ten acres of land in Hopkins, Minnesota, just outside Minneapolis.

Here, scientists—most certainly not working under poorhouse conditions—carry on basic research with only one limiting rule—the research must be directed towards improvements in the field of automatic control.

Basic research is carried on for all divisions of the corporation by the staff of more than 150, supplemented by applied research within each of the product divisions. Some of the basic areas which touch on the missile field are high-power transistors, small barium titanate transducers, infrared detection cells and basic advances in solid state physics and metallurgy.

The center works on such diverse projects as growing what are purported to be the largest tellerium crystals in existence, "promising" new methods of compounding cermets, and testing infrared cells on targets located at the end of the Center's long research halls.

When any research appears to have promise for the company, it is transferred to, and continued by, the applied research units in each of the divisions. Much of the present research now in progress in the Aero Division, largest unit of the Military Products group of Minneapolis Honeywell, has to do with gyroscopes and stabilized platforms for inertial guidance, including the gimbal-less platform and the still-secret electrostatic gyroscope.



NO FLYWEIGHT is world's smallest electrical switch. It weighs 1/28th ounce.

• **Research means health**—This heavy emphasis on research—company-financed for the most part—is probably the best reason for the current size and healthy condition of the Military Products Group (MPG). Its yearly gross of around $110 million now amounts to roughly one-third of the total company gross, and this $110 million is well spread through the three services and various other government agencies.

More than 9,000 people work for the MPG with the lion's share, 6,000, in the Aero division. The Ordnance division leads the rest in size, with 2,000 employees. The various other divisions, located in Los Angeles, Boston, St. Petersburg, and Seattle make up the balance of the company's facilities and personnel.

Most of the missile activity within the Aero division today is concerned

with inertial guidance, although M-H is a prime contractor on such systems as the *Asroc* and the still-classified *Wagtail*.

• **Gimbal-less gyros?**—One of the more interesting projects still in the research stage at Aero is the gimbal-less gyro reference system.

M-H won a design competition sponsored by Wright Air Development Center and is currently attempting to construct the system.

Some of the still-untried features now under study are digital pick-offs and torquers for the gyros, and a computing arrangement that would allow frame-fixed reference gyros in a missile. However, there are some stiff problems, so development of this system is probably some time off.

With the pick-offs and torquers, one problem is repeatability of pulse strength. With the frame-fixed reference system, a computer which will continually compute the proper orientation signals to the measuring accelerometers is, at present, the toughest nut to crack.

M-H has dubbed its system "GAINS" (Gimbal-less Analytical Inertial Navigational System.)

For more immediate applications, M-H has developed what is probably the smallest stabilized platform system now in existence (see m/r July 14), and an extremely rugged (up to 80 g's) gyro for use in smaller solid-propelled missiles.

• **Clean area**—During plant shutdown this month, the company is completing a move to consolidate all floated gyro, accelerometer and stable platform assembly in a new "white" (super-clean) area. Total clean area now is 30,000 sq. ft., but the new super-clean area will give 3,000 sq. ft. (supported by 4,600 sq. ft. for support and cleaning operations). The new area will provide for production operations that require the ultimate in extreme testing and development control.

Some of the innovations are: a Cambridge Absolute Air Filter air-conditioning system similar to those used by the Atomic Energy Commission; shoe cleaners for all personnel working in the area; walls and ceilings of non-porous vinyl; and overall ceiling lighting to avoid overhead clutter. Freon is piped into the room and is used as the cleaning agent during all parts of assembly.

Steady expenditures for new products and new techniques such as these keep M-H in a strong competitive position for the defense dollar. Since many R&D projects are company-financed, the company is in a position to undertake fixed-price rather than cost-plus-fixed-fee contracts in many business situations.

Stephen F. Keating, vice-president in charge of the Military Products group and manager of the Aero division says, "We feel that the same business philosophy should be applied to our military business as has been applied to our commercial business. Thus, if using company money for military products research enhances our position, we have no hesitation in spending."

He continued, "Of course, some projects by their nature must be handled on a government contract basis. But we try not to let those overweigh the company—initiated jobs."

• **Space flight**—The subject of space flight and M-H participation in future programs has also been given considerable attention. Company planners see something around $22 million ($13 million production and $9 million R&D) by 1962.

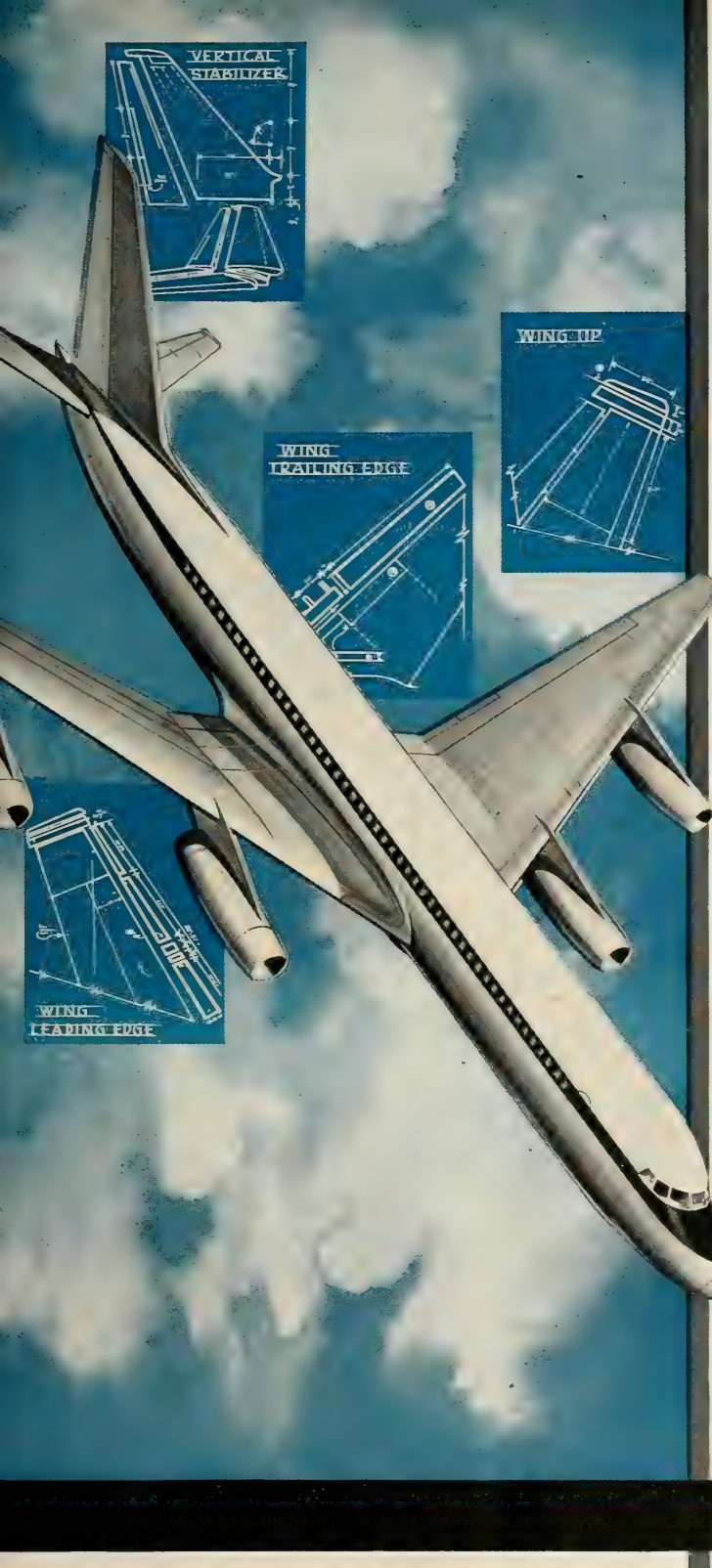
A significant item is that the $9 million is estimated at 36% of total engineering effort in 1962. Some of the projected areas are human and equipment environmental controls; improved navigational, guidance, and flight control systems; and display and instrumentation in the data processing field.

The recent announcement that M-H is participating in the Dyna-Soar project indicates that some of the plans are already turning into reality.

At present, the Basic Studies Group of the research unit in the Aero Division is at work determining the immediate areas for attention. No name has been picked yet for the space efforts, but wags around the Aero plant are already calling personnel working in that particular area the "Honey-mooners."



VIBRATION EQUIPMENT is mounted on lead mass for testing a gyroscope. An M-H test engineer views the completed setup through a thick-glass, triple-pane window.



Crosley helps CONVAIR JET 880 to keep a date

Soon the Convair Jet 880 will take to the skies as one of the world's fastest jetliners. Sleek, smooth and strong—the luxurious jet will race the sun at 615 miles per hour!

Convair has chosen Crosley to design and produce many of the 880's components. And while actual construction progresses, a Crosley team of engineers is "on site" at the plant to help insure speedy transition from design to production to maiden flight date.

Crosley's contributions to airframe construction include all of the conventional types of assembly in addition to the newer methods of honeycomb, metal bond, and chem-milling. Equally important are Crosley's contributions to safety in flight, represented by such developments as Volscan—the electronic air traffic control system, or airborne navigation and communications equipment, embodying advanced concepts of electronic application.

For further information on Crosley's airframe and other capabilities write to the Vice President—Customer Relations, Avco Manufacturing Corporation, Crosley Division, 1329 Arlington Street, Cincinnati 25, Ohio.

Avco // Crosley

NORTH AMERICAN AVIATION, INC. & PHILLIPS PETROLEUM COMPANY

INTRODUCE

ASTRODYNE, INC.

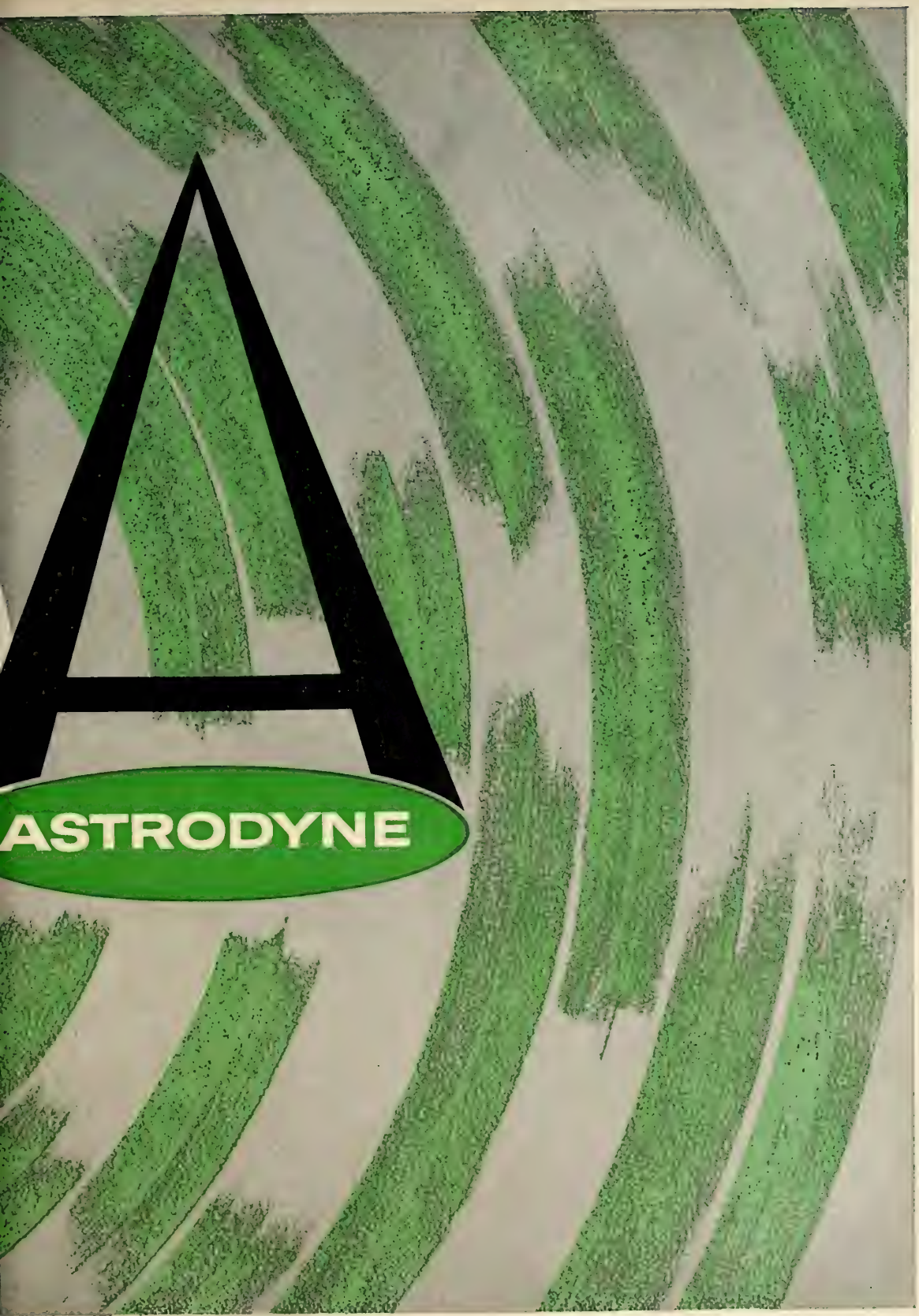
In the formation of Astrodyne, their new jointly owned corporation, North American Aviation and Phillips Petroleum Company have brought together two broad backgrounds in rocket propellants and rocket hardware.

From Phillips comes advanced research and manufacturing experience in solid propellants and JATO units. From North American comes demonstrated competence in missile systems design and the manufacture and fabrication of America's largest rocket engines.

And from these two major companies comes Astrodyne's key leadership, teamed to manage America's major missile projects.

Today Astrodyne has the experience and the facilities to design, develop, and manufacture complete propulsion systems, extruded and cast propellants, rocket engines, missile controls and hardware, boosters, gas generator charges, and auxiliary power units.

Inquiries are welcomed on any phase of the solid-propellant field—from preliminary design to quantity production. ASTRODYNE, INC., McGregor, Texas.


ASTRODYNE

Company Officers



Anthony Hass has been elected president of the Dryomatic Corp. Hass has served as vice president and sales manager of the company since 1950. Previously, he was employed as division manager of Atlantic Research Corp., and as general manager of Kilgore Chemicals, Inc., located in Washington, D.C.

Henry Arnhold has been elected chairman of the board and **John Bouwmeester** president of General Ceramics Corp., Keasbery, N.J. **Hans Arnhold** is retiring after 30 years as board chairman. He will retain his position as chairman of the executive committee and member of the board.

Brig. Gen. Edwin M. Day, USAF (ret.), was elected president of Fairchild Aerial Surveys, Inc. Former president **Leon T. Eliel** has been elected chairman of the board.



Vice Admiral Charles B. Momsen, USN (Ret.), has been elected to the board of directors and named as consultant to CREI Atomics, Inc. He is also consultant to General Dynamics Corp., U.S. Rubber, Raytheon Manufacturing Co. and the Coleman Engineering Co.

Ira G. Ross, formerly executive vice president and director of Cornell Aeronautical Laboratory, Inc., Buffalo, N.Y., has been elected president. Ross succeeds **Dr. Theodore P. Wright,** vice president for research at Cornell University. Dr. Wright, who has served as president and chairman of the board of the Laboratory since 1948, continues as chairman of the board of directors.



Paul P. Huffard, a director of the Union Carbide Corp., has been elected to the board of directors of Greer Hydraulics, Inc. Huffard joined the Union Carbide organization in 1909 and has served as vice president, president, and director of a number of Union Carbide's divisions and affiliates. He has been a director of the corporation since 1944.

William H. Moore, chairman of the board of Bankers Trust Co., New York, and **Bruce Bromley,** a partner in the New York law firm of Cravath, Swaine, and Moore, have been elected to International Business Machine Corp. board of directors to fill existing vacancies. Moore is also director and member of the executive committee of the Republic Aviation Corp., and a director of the M. A. Hanna Co. Bromley, admitted to the New York Bar in 1920, was formerly a justice of the New York Court of Appeals.

Honors

L. Eugene Root, Lockheed vice president and Missile Systems division general manager, was honored by his alma mater, College of the Pacific, with the honorary degree of Doctor of Science.

John W. Lazur has been elected director of the New York Section of the American Astronautical Society. Lazur is military operations manager at Allen B. DuMont Laboratories, Inc.

Engineering

Hans Meyer has joined the engineering staff of Richard D. Brew and Co., Inc. Formerly with Epsco, Inc., Meyer worked on design and development of delay lines and special components.

Thomas Courtney, Jr., design research specialist, has been named chief project engineer for Temco Aircraft Corp. Formerly with McDonnell Aircraft Corp., St. Louis, Courtney had major design responsibilities in development of jet fighters, and worked on the *Talos* and *Green Quail* missile projects weapon system. He also was a member of the composite design research panel for the *Bumblebee* missile.

Dr. Phillip W. Lett has been named chief engineer, and **Walter C. Beyer** assistant chief engineer of Defense Engineering at Chrysler Corp.

Graham Tyson has been appointed senior applications engineer for data handling systems at Telemeter Magnetics, Inc. Tyson was formerly with the electronic data processing division. He also was associated with Northrop Aircraft Corp., where he was group leader for research and development of data processing systems.

William H. Foulds has been named chief development engineer for Monitor Products Co., South Pasadena, Calif. Foulds was formerly with the British Admiralty Signal & Radar establishment in charge of communications.

Industry



Joseph J. Vasicek has been appointed secretary of Servomechanisms, Inc. Vasicek, who has a background in finance and accounting, joined Servomechanisms six years ago as chief auditor and assistant to the treasurer of the company.

Dr. Raymond L. Bisplinghoff and **Dr. Wayne B. Nottingham,** both senior professors at Massachusetts Institute of Technology, have been appointed to top consultant positions with National Research Corp.

James R. Jones has been appointed manager of Army contracts at Ford Instrument Co., division of Sperry Rand Corp. He will be responsible for customer relations and sales with the Army.

Dr. Carroll Barrack will head the new Electronics department of Miller Research Laboratories, Baltimore.



Dr. Allen M. Peterson heads the Communications and Radio Propagation group at Stanford Research Institute. This group is a new combination of two radio systems laboratory research groups at the Institute. Peterson's assistants are **Ray L. Leadabrand** and **Wilbur R. Vincent,** who direct research in propagation and communication systems, respectively.

L. E. Rasmussen, former plant manager, has been appointed general manager of the Cincinnati division of Bendix Aviation Corp. He was formerly with the Atomic Energy Commission as chief of the radiation instruments branch in the production division, Washington, D.C. and Oak Ridge, Tenn.



Murray S. Gelber was recently appointed treasurer of Hughes Aircraft Co. Previous to joining Hughes, Gelber was vice-president and manager of AiResearch Co., a division of the Garrett Corp. With Garrett since 1939, Gelber had served as chief accountant assistant controller, assistant to the president and vice-president of manufacturing.

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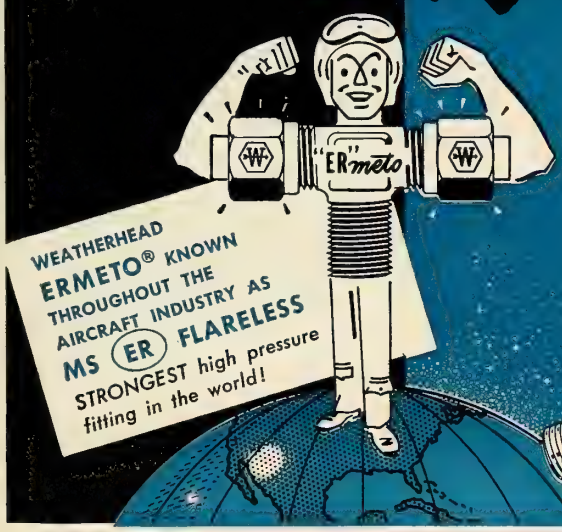
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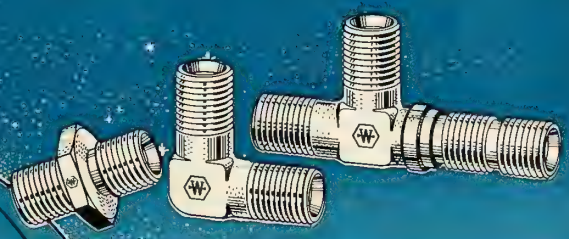
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Study Contract Awarded For New Space Ship

General Dynamics Corp. has been granted a $1-million contract by the Department of Defense, to determine the feasibility of an air and space ship which would be powered by controlled nuclear explosions.

DOD's Advanced Research Projects Agency authorized the contract, which calls for expenditure of the $1 million over a year, beginning July 1. The Pentagon said the contract would be continued if results show promise. General Dynamics' General Atomic Division, San Diego, will handle the project.

The propulsion system was proposed by GD. No further details were given beyond the fact that the system is unlike other nuclear propulsion systems proposed or under development at the present time.

General Bronze Moves Into Electronics Manufacturing

General Bronze Corp. has formed the GB Electronics Corporation, and leased 160,000 square feet of manufacturing space for the facility at Valley Stream, Long Island.

GB Electronics will occupy the site early in September, and plans to employ several hundred persons. The company is developing airborne antenna and infra-red devices for reconnaissance.

The Valley Stream plant will house complete experimental facilities. Officers of the company are A. S. Saphier, president; Peter J. Keulemans, executive vice-president; Ira Kamen, vice-president; Warren J. Freeman, vice-president and treasurer; Phineas S. Schey, vice-president; and Milton S. Salmon, secretary.

Rapid Tax Writeoffs Granted Missile Firms

The Office of Defense Mobilization has granted rapid tax writeoffs to four firms engaged in missile R&D or component manufacture. Beneficiary of the largest amount was Callery Chemical Co., Douglas County, Kans., with a $3.8 writeoff at 65%.

Others were Aerojet-General Corp., Azusa, Calif., $964,917 at 60%; Lockheed Aircraft, MSD, Van Nuys, Calif., two contracts totaling $636,167 at 65%; Lockheed Aircraft Corp., MSD., Palo Alto, Calif., two contracts totaling $483,322; Olin Mathieson Chemical Corp., explosives div., Carterville, Ill., $790,000 at 50%; Olin-Mathieson Chemical Corp., explosives div., $118,000 at 60%.

world astronautics



by Frederick C. Durant III

Exciting possibilities for the use of 90-100% strength hydrogen peroxide for manned satellites have been uncovered in the recent flurry of design studies. As a multi-purpose fluid, H_2O_2 has significant potential. Not only is catalyst-decomposed peroxide a source of thrust for satellite attitude control, but also for turbo-generated electric power. Furthermore, the products of decomposition, water, and oxygen might be used for human consumption.

The decomposition of H_2O_2 produces heat which can power refrigeration systems and regenerate certain carbon dioxide absorbents. For further information, write American Food Machinery's Special Projects Division, Buffalo, N.Y.

The British "school tie" is an ancient tradition. A modern counterpart is the British Interplanetary Society tie. Dark blue, heavy silk, with a discreet rocket and stars motif, it is available to members of the BIS for only $2.10. Address Secretary, BIS, 12 Bessborough Gardens, London, S.W.I.

The concept that "astronautics is just an extension of aeronautics" was blasted recently by ex-ARS President Capt. R. C. Truax, USN. Truax, a naval aviator, has preached rocketry and space flight for more than 20 years. He holds that it is no more reasonable to wed astronautics to aviation because a space vehicle spends a fraction of its time within the atmosphere, than to marry aviation to automotive transportation because an airplane spends a short time rolling along a runway on rubber tires!

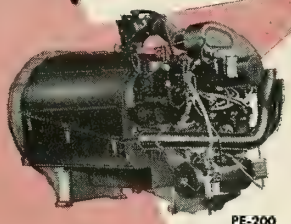
For the teenage craftsman, (and his Dad), Model Missiles, Inc., Denver, Colo. markets a complete model system kit, Rock-A-Chute. Powered by a safe, solid propellant rocket charge, a 15 in. Aerobee-Hi scale model will climb to 500 ft. A nylon parachute is automatically ejected, returning the rocket gently to earth. After capture, the parachute can be refolded, the rocket charge replaced and countdown procedure started again.

Model Missiles, Inc. is headed by rocket engineer Harry G. Stine. A Model Missile Association has been formed which publishes THE MODEL ROCKETEER monthly.

There is still speculation as to the size and configuration of the U.S.S.R. *Sputnik* launching vehicles. Some calculations were made recently by Univ. of Md. Prof. S. Fred Singer, based upon the intensity of brightness of the *Sputnik* I rocket body and the rate of deceleration caused by atmospheric drag (see p. 11 for more information).

The indications are that the rocket body may have been at least 50 ft. long, and 12 to 16 ft. in diameter. The satellite launcher was probably not a 3-staged vehicle as has been suggested, but perhaps a 1½-staged affair or a clustered rocket. All engines are believed to have been ignited at takeoff, and therefore there was no coasting period or problems associated with high altitude starts.

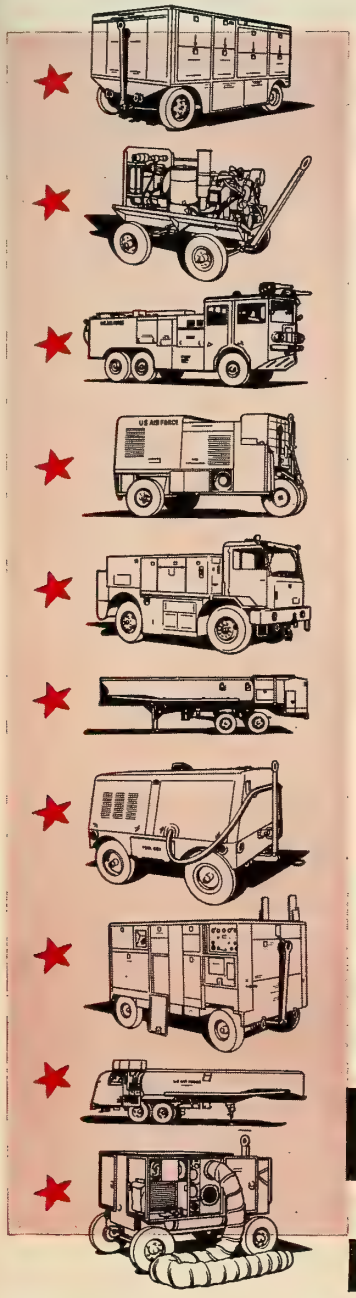
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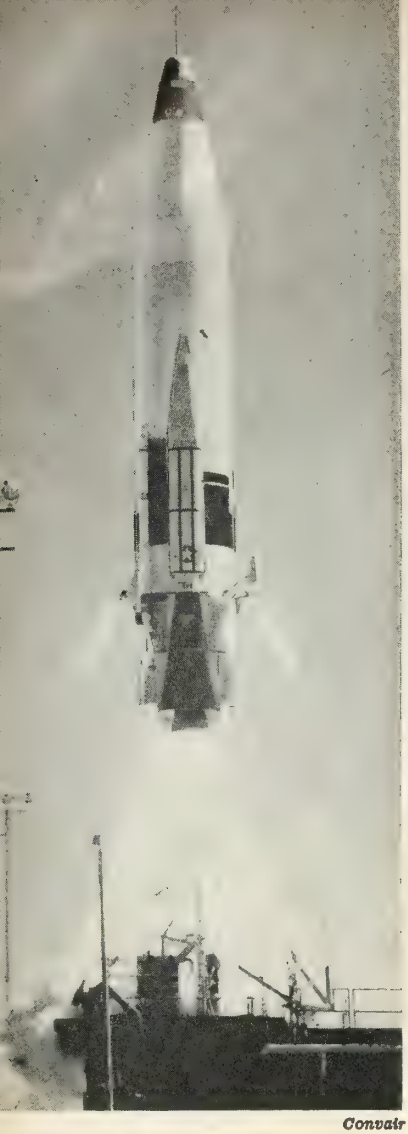
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AIRCRAFT ENGINE DIVISION

MUSKEGON, MICHIGAN



Convair

Small Engines For Big Job

Powerful Verniers That Control *Atlas, Thor* Thrust Variations Reach Operational Production Status

by Norman L. Baker

The vernier engine thrust control system for the *Atlas* and *Thor* missiles has reached an operational production status. Production and testing of this unique auxiliary missile control system is currently underway at Rocketdyne Neosho.

Rocketdyne reports that the low thrust engine system is achieving an extremely high degree of reliability in test firings. The near ultimate in simplicity of fabrication and assembly gives it a mass production capability.

The system was designed and developed specifically for directional and thrust stability of the *Atlas* missile system. Later the engines were designed into the *Thor* IRBM. Both *Atlas* and *Thor* are equipped with two of the small auxiliary power units.

The verniers provide adjustment for any thrust variations in the parallel booster engines of the *Atlas,* in addition to maintaining roll control and directional stability. On the *Thor,* with its single sustainer engine, two of the verniers mounted at the base of the rocket 180 degrees apart provide roll control and precise adjustment in pitch control.

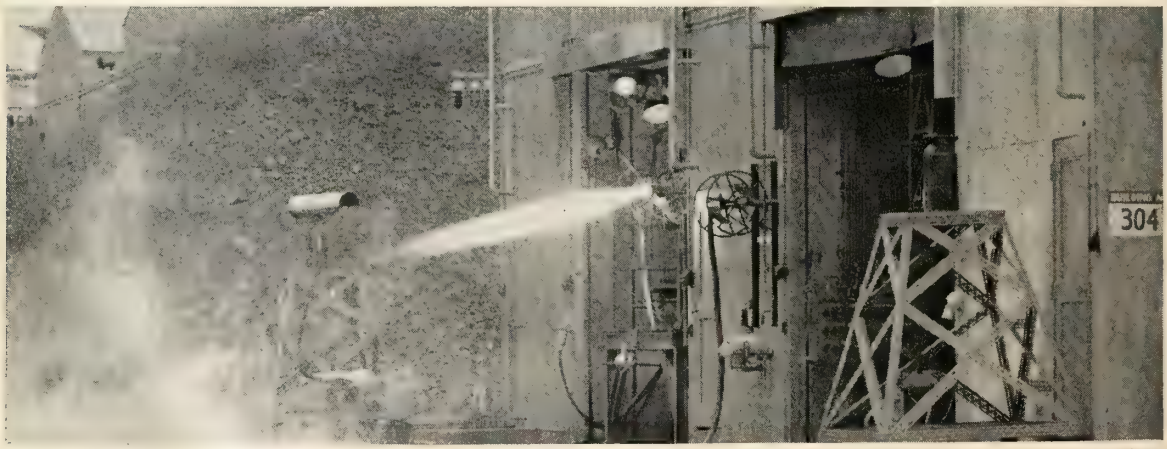
The vernier engine roll control for the *Atlas* and *Thor* reaches a high degree of sophistication when compared with the *Jupiter* system. The exhaust of the gas generator of the *Jupiter,* located at the base of the missile, can be swiveled through an 180 degree arc for supplying thrust about the vertical axis.

Gimbaling freedom of the vernier engines provides approximately 120 degrees in the roll axis and 60 degrees in the pitch axis.

The vernier engines are ignited shortly before missile takeoff. Initial thrust is reduced approximately 20% for the first few seconds of flight, when the verniers are required to provide only roll control. Thrust is provided for several seconds after sustainer engine cutoff to insure attainment of programmed missile attitude in azimuth and elevation.

The verniers operate on the missile's propellants of liquid oxygen and RP-1, a higher grade of kerosene fuel than that used in turbo-jet engines. An efficient regenerative cooling system is employed to drop the 5,000 degrees Fahrenheit combustion temperature to a safe level for sustained burning. Engines are cool to the touch after several minutes firing duration.

Rocketdyne Neosho, in addition to production testing, is engaged in a continuing development program. Hot firing tests include long duration fixed firings in order to check reliability, and thrust variation tests combined with continuous gimbaling operations.



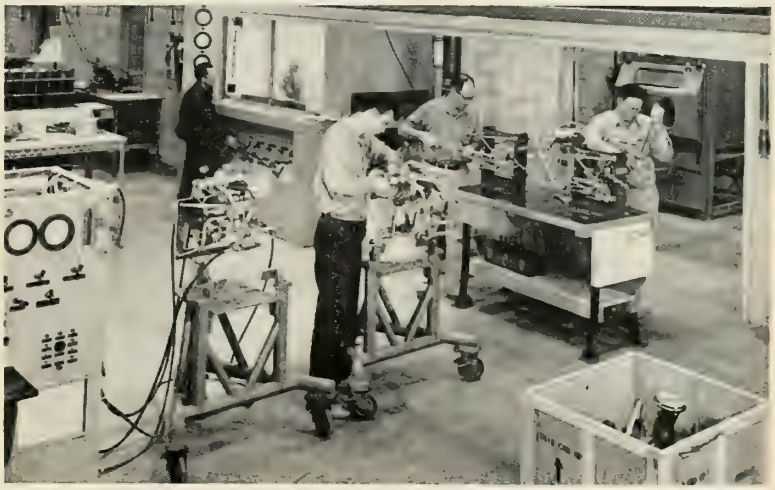
Rocketdyne

VERNIER ENGINE is subjected to long duration hot fire check. Television and movie cameras film the operation. Additional component test cell areas are in background.



Rocketdyne

WORKMEN AT ROCKETDYNE Neosho's production plant assemble complete vernier engine systems. Engines are given a routine production check before packaging. Sample hot firings of this production power package are made regularly.



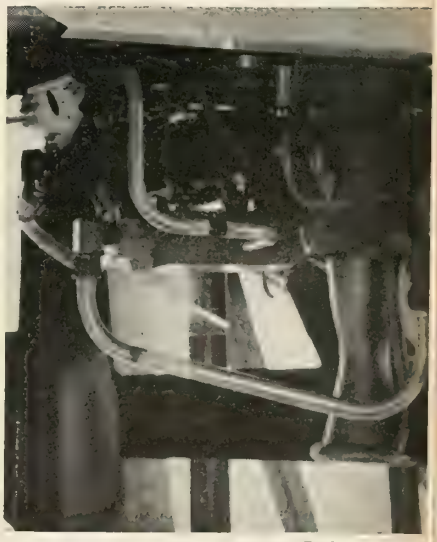
Rocketdyne

THE ENGINES are attached to moveable jigs in bench clamps before packaging for shipment to the prime systems contractor, where the engines will be installed on the missiles. Fabrication of the units requires a minimum of plant operating area.



Rocketdyne

WATCHING THE STATIC FIRING of a vernier engine: Gene Andrews, test engineer; T. S. Dowe, industrial engineer; E. E. Thiessen, test foreman; Norman L. Baker, m/r editor; E. A. Wright, factory manager; and Bill Van Dyke, public relations.



D. Perry

VERNIER ENGINE mounted on *Thor* IRBM. Another unit is mounted underneath on opposite side of the sustainer.



HIGH ALTITUDE PHOTO ABOVE EGLIN AIR FORCE BASE

FIREBEE: "ENEMY" JET OVER AMERICA

The most realistic "enemy" in the skies over America today is the Ryan Firebee. This jet-fast, elusive target drone is being used to sharpen the sights of the men who man the nation's air defense system and to evaluate the missiles upon which they rely.

The Firebee flies at the high speeds and altitudes required to test the performance of the newest, most deadly air-to-air and ground-to-air missiles. It possesses the maneuverability and extended duration needed to realistically simulate "enemy" intercept problems.

Developed by Ryan for the Air Force (Q-2A), Navy (KDA-1) and Army (XM21), the Firebee is in volume production and operational use. It is being fitted with special radar and infra-red reflective devices for simulating varied target characteristics and providing broader missile-target compatability. The Firebee can be equipped with wing pods to carry added fuel... a warhead... photo or television reconnaissance gear.

The Firebee is an example of Ryan's skill in blending advanced aerodynamic, jet propulsion and electronics knowledge to produce a highly successful solution to a complex aviation problem... meet a vital military need. Other examples are the Air Force-Ryan X-13 Vertijet and Navy-Ryan AN/APN-67 automatic navigator for global jet flight.

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Ryan Aeronautical Company, San Diego, Calif.



propulsion engineering

by Alfred J. Zaehringer

Ion rocket engine of ½ lb. thrust is being built by NACA. Electric field will accelerate cesium ions to speeds of 300,000 miles/hr. NACA has reached exhaust velocities on the order of 400,000 miles/hr. in other experiments.

Erosive burning of colloidal propellants is receiving considerable research attention in France. Present theory is based on existence of a turbulent layer near the burning surface, resulting in a thermal and diffusion effect. The diffusion effect is more pronounced at low pressures prevailing in rockets.

New low cost nitric acid process placed in operation by Hercules Powder should interest rocket people. A magnesium nitrate process produces sulfate-free, concentrated (99+%) acid—almost chemically pure at technical grade price. The 50 ton per day unit at Parlin, N.J. could go to 150 tons per day.

Nitrogen tetroxide is being studied as a replacement for LOX at Redstone Arsenal. N_2O_4 is a liquid at normal temperatures (boiling point is 70°F) and gives a density times I_{sp} of 330 sec with hydrazine, as compared to 290 with LOX. Biggest headache with the oxidant is high freezing point (12°F), however this may be solved by warming or by the use of freezing point depressants.

Easy-to-handle ethylenimine is hypergolic with concentrated nitric acid, the Chemirad Corp. reports. The fuel can also be mixed with gasoline, alcohol, furfural, or other fuels for rocket use.

Polycyclic aldehydes make hypergolic rocket fuels. Phillips Petroleum has patented substituted tetrahydrofurfural and homologs as new bipropellant fuels.

Acetylene dissolved in ammonia or anamine makes a high energy fuel when burned with limited amounts of oxygen. Aerojet finds that the low combustion temperature (2600°K) produces much hydrogen. One mole of acetylene and 2 moles of ammonia with 1½ moles of oxygen gives an I_{sp} of 260 sec.

Ban on nitromethane: Tank car shipments of this monopropellant have been halted after two million dollar explosions. One was at Mount Pulaski, Ill., and the other at Buffalo, N.Y. Cause is not known.

Zirconium powder has a combustion temperature of 4,930°K in oxygen at 1 atm pressure. Temple University researchers believe that hafnium, lanthanum, thorium, or zirconium have the highest combustion temperatures of all metals. These metals, however, do not have the highest heats of combustion.

Cosmic dust as a rocket propellant? Despite low densities of galactic dusts and the necessary high vehicle speeds, several schools of thought believe that a high I_{sp} intermittent detonation engine might work on such dusts.

Materials Research Program Advocated by ARDC General

Maj. Gen. Marvin C. Demler, deputy commander of the Air Research and Development Command, has called on industry to participate in a voluntary nationwide R&D program to meet the materials requirements of "the space age challenge."

Gen. Demler made the appeal in a keynote address opening a two-day ARDC-sponsored Materials Technical Symposium in Dallas, which drew an audience of 1,000 military and civilian scientists and engineers.

"The materials research and development problems created by advance aeronautics have been compounded by space flight," he told the delegates. He added that improvement in the performance of new weapons called for improvement of the basic materials of which their component parts are built.

Liquid Rocket Powerplant Completed Ahead of Time

Reaction Motors Division of Thiokol Chemical Corp. has completed a development contract on a packaged liquid rocket powerplant some two-and-one-half months ahead of the Bureau of Aeronautics contract schedule.

The packaged liquid powerplant includes propellant tanks and thrust chambers, all shipped complete with factory-load propellants.

Most probably, "liquid packaging" will be used initially on small missiles carried by Navy aircraft. *Sidewinder* and *Bullpup* are under consideration at the present time.

Radar Aids Safety Officer At Cape Canaveral

Residents in the vicinity of the Air Force Missile Test Center at Cape Canaveral will probably welcome the news that destruction of an off-course missile is not dependent solely on the decision of a human being. The button is pushed by the Range Safety Officer, who is aided in his decision by an elaborate arrangement of radar and computing devices.

Because of the speed of a missile and the relatively short time in which a decision must be made, eight ground radar antennas, part of the AZUZA tracking system, follow the missiles upward flight after launch. Data is fed into an IBM 704 computer, which computes the exact landing point every ten seconds in case of engine failure.

The computer output is displayed graphically in the central operation room, where two lines on a map indicate the safety limits of the firing range.

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Army C. of E. Gets Go-Ahead on Missile Sites

A final go-ahead for construction of a *Titan* launching pad at the new Pacific Missile Test Range has been given the Army's Corps of Engineers, according to Maj. Gen. Walter K. Wilson, Jr., deputy chief of engineers for construction.

At a press conference in Los Angeles, Gen. Wilson said that other facilities for the *Thor, Atlas* and *Titan* will be built at the new range, but he declined to say how many, or when completion could be expected for these missile facilities.

A test facility for the Army Ordnance Missile Command will be constructed at Camp Irwin, near Barstow, Calif., in the southern desert. With a probable cost of over $30 million, the desert site will be an extension of the Army program being conducted by Jet Propulsion Laboratory. No missiles will be fired from the Camp Irwin area; operations will be confined to static tests for fuel development and power plant studies.

Gen. Wilson said that the joint Army-Air Force construction program during the past fiscal year totaled more than $1 billion—10 to 15% of which was for missile sites. He said this percentage for missile site construction is expected to jump to between 25 and 30% of the total expenditures for the current fiscal year.

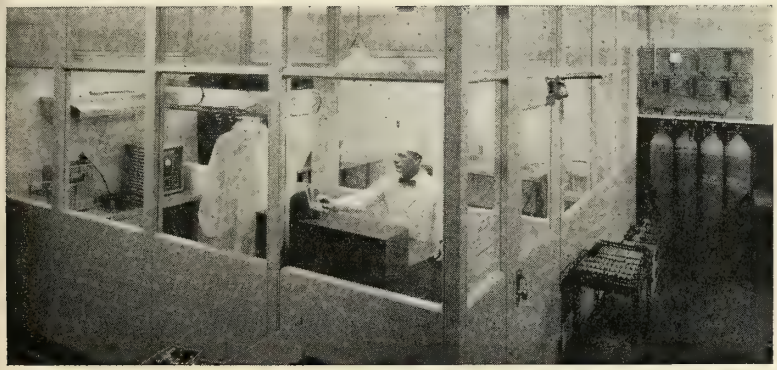
Some facilities constructed for the *Nike-Zeus* program at White Sands Proving Ground are expected to be ready for occupancy this month. However, Gen. Wilson pointed out that the *Nike-Zeus* program is in its "infancy," and the decision to fund for an all-out program has not been made at present.

Asked if the present *Nike-Ajax* sites could be used when the *Nike-Hercules* is phased into operation, the general said that the "tailored" nature of missile development precludes even a second generation of the same missile family from using the same facilities. It was noted, however, that there are some *Nike-Ajax* sites, built as what he termed the "second series," that could be adapted for *Nike-Hercules* operations.

Nike-Hercules units will probably not be put into operation in the southern California area this "calendar year," Gen. Wilson said, but will probably be ready sometime in "the current fiscal year."

Asked if the Los Angeles area would be a high priority district for the *Hawk* anti-aircraft missile, the Army officer said that it probably would not be designated as such. The region is not considered a primary target for such attacks.

Impurity-Free Chamber for Parts Processing



"Clean room"—working areas with controlled, dust-free atmospheres—aren't limited to the guidance manufacturers. The Superior Valve and Fittings Co. of Pittsburgh recently placed in operation a 16 x 16 ft. room for processing precision valves and parts for missiles.

In the glass-enclosed chamber, manual control valves are ultra-sonically cleaned, tested, assembled and packaged in heat-sealed polyethylene bags. Present units being manufactured are automatic fuel control valves for Douglas Aircraft Co.

Other factors in the "clean room" besides the elimination of dust are the control of temperature, moisture, atmospheric pressure, vibration, illumination, ventilation and noise.

In the room, all valve parts are cleaned in an ultrasonic trichlorethylene bath, which removes 96% of all particles down to one micron in size. Stainless steel or polyethylene containers are used throughout, and all parts are inspected under ultraviolet light for any remaining traces of hydrocarbons. When testing is finished, completed valves are capped and plugged with ultrasonically cleaned plastic caps, and then sealed in polyethylene bags.

Advanced Camera Tube "Sees" the Unknown

An advanced type of camera tube, based on televison principles, has been developed by RCA. The tube may help disclose unseen details of the planets and distant nebulae.

Known as the Intensifier Orthicon, it is reportedly 100 times more sensitive than the fastest film for the same exposure time, at low light levels.

The tube was developed by Dr. George A. Morton and Dr. John E. Ruedy at RCA's David Sarnoff Research Center, Princeton, N.J. The research program was sponsored by the Aeronautical Research Laboratory at the Wright Air Development Center.

Operating on principles employed in the Image Orthicon used in present television pickup functions, the tube can "see" in surroundings which appear completely dark to the human eye.

Missiles Almost Half Of Army Hardware Plans

Of the $1.6 billion the Army plans to spend on hardware in fiscal 1959, almost half is earmarked for missiles. *Redstone* heads the missile money list with $109 million.

The Army estimates that surface-to-surface missiles, like *Nike-Hercules, Nike-Zeus* and *Hawk,* will take another $503 million.

The request submitted to the Senate Appropriations Subcommittee also included: *Sergeant*—$44 million; *Lacrosse*—$36 million; *Honest John* and a successor to *Little John*—$35 million.

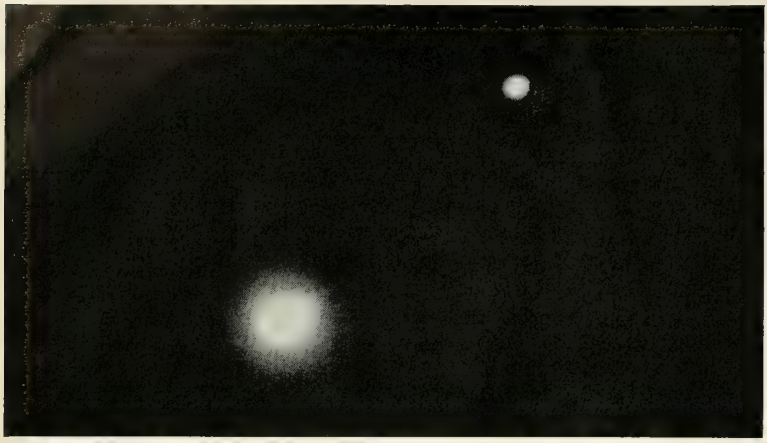
Nike Mobile Trainer Ready for Use

International Telephone and Telegraph Corp. is producing a mobile trainer for use at *Nike* missile centers.

Housed in a 20-foot trailer, the trainer can inject six synthetic aircraft targets into control radars, with each of the simulated targets having the characteristics of extremely fast, maneuverable planes.

Creation of the trainer, according to ITT, eliminates the necessity of using aircraft for training operations. The device can simulate target speeds of up to 2,300 mph, with a maximum target range of more than 100 miles. It can also simulate target altitudes up to 80,000 feet; maneuvers, including climb rates, up to 40,000 feet a minute; and dive rates up to 80,000 feet a minute.

Here's How "*Gaslight*" Looked to Observers



10 SEC.—First to appear was booster, closely followed by smaller instrument package.



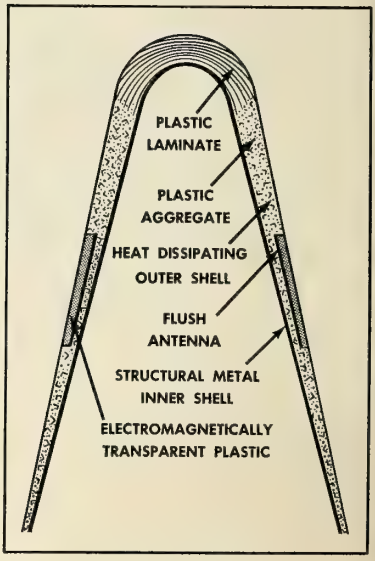
13 SEC.—As components descended, nose cone was visible, leading trio to earth.



19 SEC.—Instrument package burned out, booster, slowed by friction, lags behind nose.

Army and industry observers gained significant new re-entry and anti-missile data from the photographic, spectrographic and radiometric studies of the May 18 firing of a *Jupiter* nose cone that was recovered (m/r July 14, p. 14).

Spectral and radiometric measurements were made by special meteor type spectral cameras and radiometers designed by Barnes Engineering Co., Stamford, Conn. Other members of the *Gaslight* team included scientists from AVCO Research Laboratory, Aerojet General, AF Cambridge Research Center and ABMA. "Gaslight" was carried out under the direction of David D. Woodridge and Ray V. Hembree of ABMA.



Plastic Covers Cone

Developed under a contract of less than $2-million by Cincinnati Testing and Research Laboratories, Inc., the protective coating for the *Jupiter* IRBM nose cone is a striking example of the contribution to missilry that small companies can make. Designed to ablate and utilize a CTL proprietary phenolic resin as the basic material, *Jupiter* employs a modified asbestos "down-wind" laminate for the thickest section, graduating to an asbestos-phenolic aggregate for the back part of the cone. Indications are that about 16 laminations are used, and that the thickest part of the coating is on the order of four inches. A pattern of flush antennae are arranged around the cone. The structural inner shell is reported to be aluminum. The cone is being investigated for possible application to *Atlas, Titan, Polaris* and *Minuteman*.

USSR Re-entry Solution Duplicates U.S. Method

Russia's answer to the heat problem in IRBM and ICBM reentry nose cones concurs with U.S. technology. U.S.S.R. engineer, Colonel K. Malyutin, writing in SOVETSKIY FLOT (Soviet Fleet), reports that "to combat aerodynamic heating, rockets are given a highly finished streamlined form and the head portion is made of high-temperature alloys or . . . special compounds of phenol resins with ground asbestos. Sometimes the shell is made of laminated plastics, the layers of which successively burn away during severe areodynamic heating." This translation of SOVETSKIY FLOT was reported by Commerce Department's Office of Technical Services.

Laminated phenolic resins combined with a phenolic-asbestos aggregate provide the basic solution to *Jupiter* nose-cone re-entry. This coincides very closely with what Russia says she is doing. In addition, the Russian article suggests the use of transpiration cooling, where fuel is forced through minute openings in the missile shell with resultant cooling due to evaporation.

This same article, without indicating specifically that the vehicle mentioned is of Soviet design, describes the ballistic rocket as a three-stage, cigar-shaped wingless object with a pointed nose housing the payload. The first stage employs aerodynamic stabilizers and rudders which control the rocket's course up to 18-to-24 miles altitude. In space, control is effected by means of exhaust gas vanes (jetarators) made of high temperature alloys, or, depending on the specific design, gimbaled motors.

Industry to Obtain Space Bill "Rights"

Strong industry objections to the civilian space agency bill provision giving the government all patent rights on inventions which would result from the program has helped bring about a Congressional change-of-heart.

The conference committee which met last week to iron out differences in the House and Senate version of the bill issued instructions that an amendment was to be written which would grant the government non-revokable royalty-free license, while industry would keep the commercial rights. (see p. 33)

Navy Gets 84-ton Heater to Speed Missile Work

The Naval Ordnance Laboratory in Silver Spring, Md. is installing an 84-ton heater to supply extremely hot air at enormous pressures for use in a new hypersonic wind tunnel under construction. The heater system is part of the Navy's multi-million dollar program to step up ballistic missile development by expansion of the laboratory's aero-ballistic plant.



OPTICAL MEASUREMENTS of the incandescent nose cone and rocket body of the *Jupiter* IRBM during re-entry over the Atlantic Ocean (opposite page) were obtained by Avco Research Laboratories in participation with an inter-service team organized by the Army.

Avco recorded three kinds of optical data: (1) radiation intensity, (2) spectral distribution of emitted light, and (3) color motion pictures of the incandescent re-entering bodies. To detect and record radiation intensity at eight significant wave lengths, Avco developed an eight-channel, portable, photo-electric device, known as the Mark II Radiation Recording System.

Radiometer Developed For High-Speed Missile Measure

One of the instruments used for tracking purposes during the recent successful *Jupiter* re-entry experiments was the Wide-Field Radiometer Model R-4K1. Designed and manufactured by Barnes Engineering Co. of Stamford, Conn., specially for "Operation *Gaslight*" (see m/r July 14, page 14), this instrument weighs 13 pounds and is constructed to be held and pointed like a shotgun.

It consists of an optical head and an electronics unit, connected by a single cable. The optical head is equipped with a gunstock and pistol grip for ease of handling and rapid acquisition and tracking of the target.

A major feature in target acquisition and tracking is the wide—up to 4° —circular field of view.

The detector and amplifier are combined in an easily interchangeable package for measuring targets at widely different temperatures. Available for use are lead sulfide, infrared photomultiplier, and germanium immersed thermistor bolometer detectors, all packaged with matching preamplifiers.

The Model R-4K1 has provisions to optimize its function for day or night operation. Total radiation chopping is used for night measurements, while space filter chopping is used during the day to suppress uniform background signals by several orders of magnitude.

An illuminated-recticle type telescope sight is used to permit easy target acquisition and tracking.

The optical head can be removed from the gunstock and mounted on a high-speed pedestal, radar antenna, infrared tracker mount, or optical tracker mount, for simultaneous use with other instrumentation.

First Infrared Detection of Re-entry Achieved

The first successful infrared detection of an approaching ballistic missile has been achieved. The announcement by the U.S. Army and Aerojet-General Corp. revealed that in the experiment, conducted aboard missile tracking ships off the Lesser Antilles Island Group in the Atlantic, a *Jupiter* test vehicle was followed by a portable radiometer as it re-entered the earth's atmosphere until it plunged into the ocean.

The equipment was developed by Aerojet-General and consists primarily of a radiometer telescope with field calibration source, a 16mm. motion picture camera, automatic recorder and batteries. Resulting data included measured intensity of infrared radiation and photographs of the re-entry.

Army Unhappy on *Nike-Zeus* Cut

Strong elements in the Army are miffed at Defense Secretary Neil H. McElroy for deciding against committing *Nike-Zeus* to production.

Here is the issue:

Defense Department has lopped off some $507 million the Army requested for the anti-missile missile. Many Army leaders feel this could delay production and deployment of defense against the ICBM for almost a year.

Basically, the Army feels that its *Nike-Zeus* is worth buying now, while McElroy, upon the advice of his scientific advisers, favors postponing a decision to buy until the missile is further developed and its capabilities more fully proven. The DOD secretary has ordered maximum speed in the research and development phase of ballistic missile defense, instead of obligating millions for *Nike-Zeus*.

His advisors, principally in Advanced Research Projects Agency, feel that *Zeus* has not advanced far enough to become the best defense against the ICBM, and that it would be wasteful to spend money for tooling and new facilities, ahead of knowledge.

• **Army views with alarm**—Army, on the other hand, after study of many types of anti-missile systems, firmly believes that the one with the highest hope of success is *Nike-Zeus* and that it can provide—at an early date—a reasonable ICBM defense.

As one Army ordnance general puts it: "The risk of not going ahead is worse than the risk of going ahead." The Ordnance Command feels that it is more important now to attain some degree of readiness instead of waiting until research provides a better system. At present, *Nike-Zeus* is the only anti-missile under development. DOD does not intend to fund *Talos* as an AICBM.

Present funds will allow Army to produce only prototypes of *Nike-Zeus*, and Army contends that additional funds in the present fiscal year budget would provide ready weapons during the prototype period. These could be deployed, providing at least a partial defense on an area, rather than a point defense basis. At the same time, research could go ahead on second and third generations of the *Zeus*.

Many Army leaders, including General Maxwell Taylor, have estimated that the Army will need $6 billion over a period of years in order to provide adequate defense against the ICBM.

• **ARPA view**—ARPA scientists, however, have advised McElroy that there are a great many unknowns in the problem of intercepting an ICBM. ARPA, which has a budget of $157 million for ICBM defense, of which $57 million will be turned over to the Army for further research on *Nike-Zeus*, is not convinced *Zeus* is the best system.

Chief scientist Herbert York wants to investigate the various phenomena that occur on re-entry. It is known that when a warhead enters the atmosphere—about 60 miles up at speeds on the order of Mach 22—it produces a very large acoustical shock. This ionizes the air and could provide a means for determining parameters that are needed in order to shoot it down.

York estimates that if the warhead is detected 300 miles out—which presumably would be a good figure for the range of *Nike-Zeus*—there would be only a 60 second reaction time. If research uncovers some phenomena that detects an ICBM on its way up, reaction time for an AICBM would be on the order of 25-30 minutes.

Army feels that if it gets the $507 million for additional procurement in the fiscal year 1959 budget which Congress has yet to approve, that 35% of it could be obligated in the first quarter, and the rest would be distributed over the remainder of the fiscal year.

Even a supplemental appropriation next January would still cut eight months from the operational capability of the missile, Army says. If funds are made available, Army plans a *Nike-Zeus* production program in late 1959.

Congress still hasn't made up its mind on *Nike-Zeus*. It could restore some of the money Army says it needs, but restoration probably would be less than half of the one-half billion.

There are about 40 subcontractors involved in the program. Western Electric is prime contractor, and Bell Telephone Laboratories has the prime research and development responsibility. Douglas Aircraft will make the missile, and RCA the transmitters. The overall system includes acquisition radar, tracking radar, missile trackers and the defending missile and launcher complexes.

McElroy has assigned Army the responsibility for developing the missile and launch systems. Air Force has responsibility for developing the early warning system, called BMEWS, of which the Wizard program is part of the detection program.

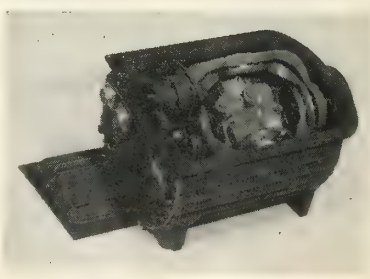
DOD Standardizes Format For Tech Data on Parts

The Department of Defense has prescribed a standardized format for technical information which contractors must submit to the military, in order to estimate requirements for initial spare parts.

Up to now, data concerning life expectancy and functioning of parts or components has been submitted by contractors in varying forms and degrees of detail.

The new procedure will be implemented within 90 days, and be effective, regarding contracts, within 180 days.

Miniaturized Stable Platform Revealed



The Area division of the Minneapolis-Honeywell Company recently revealed details of a miniaturized stable platform designed for use in missiles where size and weight are prime considerations.

The new unit uses MIG (miniature integrating gyro) and accelerometers, and is completely encased in an aluminum housing with external power connections brought in through AN-type connectors. Dimensions are 11" long x 9.5" in diameter.

The MIG units, in use in other applications for more than a year, measure 2.5" long x 1.75" long and weigh about one-half pound each. Angular momentum is 10^5gm/cm^2/sec, and drift rate is less than 0.5 degrees/hour.

Under trim with each warmup, the random drift rate will be in the order of 0.15 degrees/hour. Drifts due to ainsoelasticity in gimbal and motor structures are 0.02 degrees/hour/G^2 at the maximum.

A design feature in the MIG is the combining of the signal and torque generators into a single dual-microsyn called the Dualsyn. The Dualsyn uses 16 poles and 4 sets of 0.0045 wire windings (twice the thickness of a human hair) to become an AC pickoff and either an AC or a DC torquer. With the Dualsyn at one end of the MIG case, the gimbal is in the other.

The new platform was developed as a company-financed project. M-H officials were unable to predict future applications, but indicated that negotiations were in progress with "at least one of the services."

Support Reorganization Bill

Adm. Radford Calls Existing Act Refuge For "Roles and Missions" Prerogatives: House Okays $1.72 billion construction

by Frank G. McGuire

The very law that tried to insure a unified defense establishment has been blamed as part of the underlying cause of poor co-operation in the Defense Department.

Admiral Arthur W. Radford, USN (Ret.), former chairman of the Joint Chiefs of Staff, told the Senate Armed Services Committee that the existing law is often used as a shield behind which individual services hid in order to prevent elimination of their functions or missions.

According to Radford, when duplication of functions or missions forces the Secretary of Defense to consider eliminating the overlapping area the affected services cite the law prohibiting him from doing so. It is often claimed that the particular function involved is a "Basic Pillar" of that service's roles and missions, and removing this "pillar" from the defense setup is illegal in view of the roles and missions assignments guaranteed with the establishment of the Defense Department. Radford stated that the possibility of the Secretary of Defense being called before Congress to explain his "illegal" actions causes a delay of weeks or months in a decision on the matter.

Radford told the committee that he was greatly disappointed in the amount of co-operation given the Secretary of Defense by the military departments. He strongly urged support of the House reorganization bill (HR 12541) with the amendments recommended by the President.

Asked where he thought the government could save money through the proposed reorganization, Radford stated that he didn't think defense expenditures would actually go down anytime in the near future. He said, however, that he believes the existence of so many types of weapons is a waste that might be eliminated under reorganization.

Admiral Radford was supported in many of his statements by Sen. Stuart Symington (D-Mo.), former secretary of the Air Force. Symington and Radford obviously saw eye-to-eye on many of the alleged faults of the present system.

• **Other Activity** elsewhere on Capitol Hill:

The Navy assured the House Armed Service Investigating Subcommittee that it is not following a policy of awarding contracts for propellants to private firms while its own facilities "die on the vine." A flurry of reports that the Indian Head, Md., powder factory was laying off 2,000 employees, while Aerojet-General received a $10 million contract for *Polaris* propellant caused congressmen to react with an investigation.

The investigation is not expected to be limited to the Indian Head matter, but will probe broad aspects of government investment in private weapons facilities. About five such cases are believed to be on the agenda for the subcommittee.

RAdm. Paul D. Stroop, chief, Bureau of Ordnance, told the subcommittee that the Navy had made a $23-million management-control arrangement with Aerojet.

As far as the contract for *Polaris* propellant is concerned, Stroop said, Aerojet was, at the time of the decision, one of only two firms capable of making the propellant needed. Thiokol was the other firm considered.

"Aerojet had extensive Navy-owned facilities at Sacramento which were being used for limited JATO production, and these facilities were available for work on *Polaris* with suitable modifications," he said.

Later, Aerojet president Dan A. Kimball told House investigators he could see "no logical basis" for the controversy. Kimball told the congressmen that it should "never have arisen, because we are in an entirely different kind of business. We cooperate with, but we are no sense a competitor with, Indian Head. Our purposes and processes are entirely different from theirs, and our positions in the missile field, while related, are not parallel."

Other action in the House saw a $1.72-billion military construction authorization bill for FY 59 passed and sent to the Senate. A large portion of the total is earmarked for missile-related construction and other uses. Over 50% of the Army authorization is slated for construction programs in the SAM category, research and development, and training.

Of the total amount, $288 million was authorized for Army; $319 for Navy; $957 for Air Force; $39.9 for the Reserves; and $50 million for ARPA; plus about $64.5 million for deficiency authorization.

Conferees Approve Space Agency Bill

Senate and House conferees have unanimously approved a bill to create a new civilian space agency and to back the President with a nine-man council to advise him on space problems.

The compromise bill was praised by both Senate Democratic Leader Lyndon Johnson (Tex.) and Rep. John McCormack (D-Mass.), who agreed that it improved on versions passed by both the House and Senate. Both expressed hopes that the Congress would act quickly on the measure and send the completed bill to the President for his signature.

President Eisenhower had asked the legislature to create a civilian space agency, using NACA as a nucleus. Johnson said the bill is "in conformity" with the administration's views.

The Conferees also approved provisions in the bill which would create a National Aeronautics and Space Council. Previously, the Senate had approved a seven-member space policy board with broad policy-making powers, and the House had approved a 17-member advisory panel for the director of the new agency.

Under the approved version, the President would be the chairman of the nine-member council and therefore responsible for final action. The advisory council would have comparable status with the National Security Council, and would be composed of the Secretary of State, Secretary of Defense, the head of NASA, the chairman of the Atomic Energy Commission and four others to be selected by the president.

Missile Test Trucks Pass Road Tests

First two of an undisclosed number of tactical mobile missile test stations built by Convair under U.S. Marine contract, have successfully completed road testing.

The battery missile test trucks to be used for *Terrier* missile checkout under tactical conditions are constructed on government furnished four-wheel drive, three-quarter ton, M-37 cargo trucks.

In addition, the contract calls for a number of missile repair vans which will be equipped to repair missile components rejected during checkout.

Typewriter Manufacturer Enters Missile Business

The Underwood Corporation has entered the missile business field through the purchase of the Canoga Corporation of California.

"The Canoga Corp., which has plants at Van Nuys, Calif., and Ft. Walton Beach, Fla., has been engaged in the development of missile range instrumentation, radar systems, ground support equipment, and telemetering systems, and will remain in those fields. The division is expected to more than double its personnel within a year.

"The Underwood Corp., which grossed more than $77 million last year, expects to increase that amount substantially. Underwood will acquire other organizations in the missile field, with the full intention of moving into the business on a large scale."

Mr. Paul H. Ryckoff, president of the Canoga Corporation, will head the new Canoga division of Underwood.

Convair Gets $314 Million *Atlas* Design, Development

A letter contract has been issued by the Air Force to Convair (Astronautics) Division of General Dynamics Corp. for $314.3-million for past and present research, development and design of the *Atlas* intercontinental ballistic missile and supporting equipment.

The contract announcement was made by Major Gen. Ben I. Funk, ballistic missiles manager for the Air Materiel Command, at the dedication of the new $40-million Convair-Astronautics plant at San Diego. Cost of the plant and its equipment has been shared equally by the Air Force and General Dynamics Corp.

The new contract is in the form of a supplemental agreement to the basic *Atlas* contract, Gen. Funk said. It puts into formal form a previous letter contract, and "represents a substantial effort on the part of Convair in the prosecution of the *Atlas* ICBM program."

This was the second *Atlas* contract announcement made by the Air Force. In January 1957, an initial allocation of $145-million to cover part of the design, fabrication and testing costs of the 6,325-mile *Atlas* was disclosed.

Man-In-Space Panel Named by ARPA

The Advanced Research Projects Agency has named a panel to study the problem of Man-In-Space. Two classes of members make up the panel: voting and non-voting. Voting members include: Dr. Samuel B. Batdorf, chairman; Capt. Robert C. Truax, USN; Richard B. Canright; R. S. Cesaro; C. R. Irvine; Dr. Arthur J. Stosick, and Robertson Youngquist.

Additional non-voting members of the Man-In-Space panel attend primarily in a monitoring capacity.

Dr. Batdorf is technical director of Lockheed's Missile Systems Division and a specialist in materials engineering. Capt. Truax, past president of the American Rocket Society, has been assigned to the WS117L project. (Project SNAP, see p. 7) with the Air Force's Ballistic Missile Division, and joined ARPA three months ago.

Canright is a member of the NACA subcommittee on rocket engines and chief of the missiles powerplant group at Douglas Aircraft. Dr. Stosick is chief of the rockets and materials division at JPL, and is a specialist in physical chemistry, propellants and metallurgy.

ARPA's staff is less than 50 scientists and management experts, who are responsible for such projects as the Man-In-Space program. The proposed ARPA budget listed $46.2 million to finance the program.

Stanford to Maintain Document Depository

The Atomic Energy Commission has contracted with Stanford Research Institute to maintain a classified documents depository to serve the Western part of the country. The depository includes about 7,000 reports dealing with various aspects of nuclear energy research.

The AEC maintains similar depositories in other parts of the country for the use of firms holding AEC access permits. About 140 such firms are in California. Arrangements for use of the SRI depository may be made through AEC's San Francisco operations office.

Lockheed Space Lab To Expand Double Its Size

The Space Communications Laboratory at Lockheed Missile Systems Division, Sunnyvale, Calif. will be almost twice its size in mid-August when an 8,000 square foot addition is scheduled for completion.

Work on the $115,000 addition, which will be used mainly for offices, has been started. The new unit will also permit expansion of laboratories in the present 10,000-square-foot building. Lockheed's satellite tracking station will also be expanded.

advertiser's index

American Airlines, Inc. 6

Astrodyne, Inc. 18, 19

Avco Mfg. Corp., Crosley Div. 17

Continental Aviation & Engineering Corp., Sub. Continental Motors Corp. 23

Convair-Fort Worth, a Div. General Dynamics Corp. .. 13

English Electric Co., Ltd. ... 3

Grand Central Rocket Co., Inc. 36

Northrop Aircraft, Inc., Radioplane Div. 2

Research & Advanced Development 35

Ryan Aeronautical Co. 26

Weatherhead Co., The, Aviation Div. 21

Wyman-Gordon Co. 4

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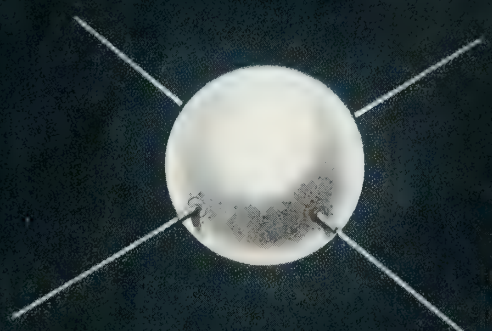
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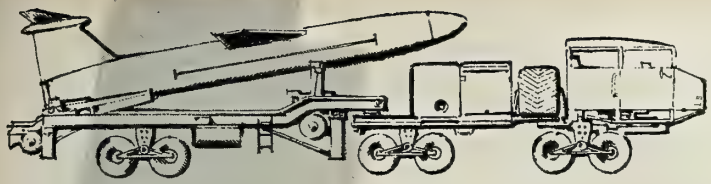
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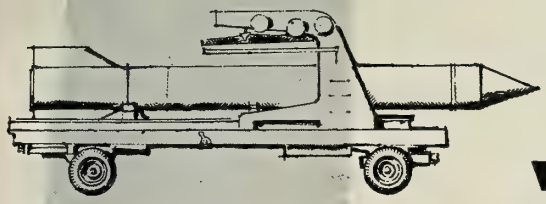
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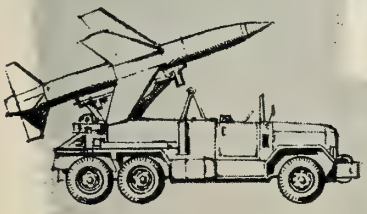
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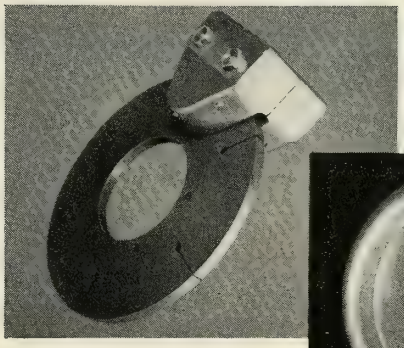


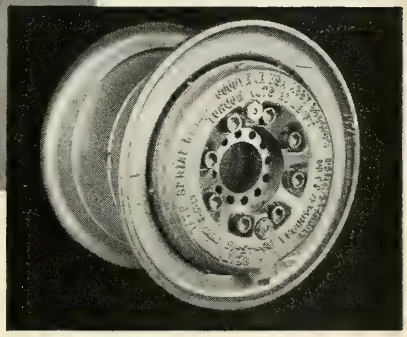






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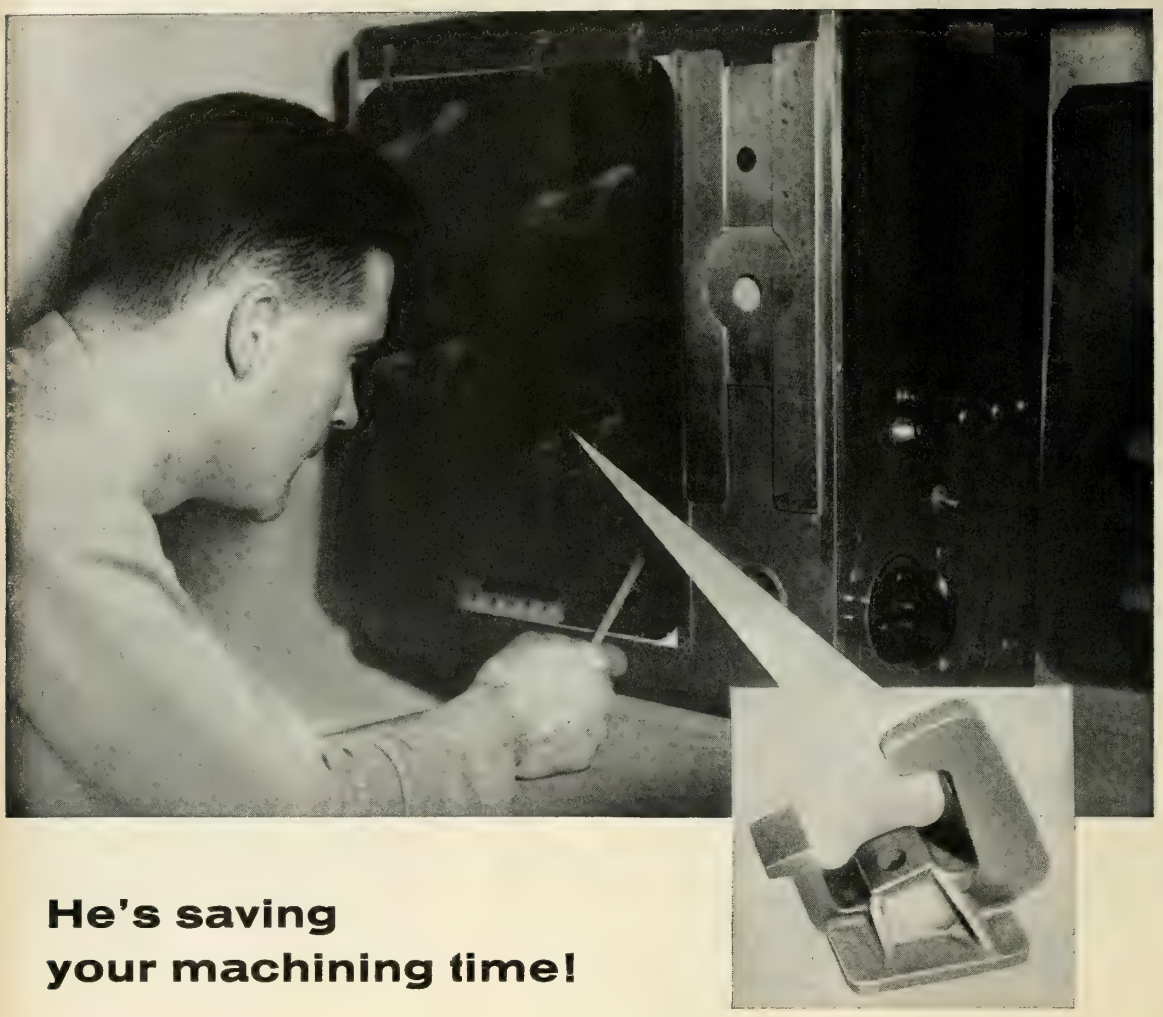
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Contents

news

How the Air Force looks at Contracting
an exclusive interview with Lt. Gen. C. S. Irvine
by William O. Miller 49

features

AFBMD: Catching Up With the Soviets
by Maj. Gen. Bernard A. Schriever, USAF 53

BIG CHALLENGE: Missilizing Our Navy
by RAdm. K. S. Masterson, USN 60

Army Pushing Brush-Fire Missiles 66

Why USAF Plans Billions For Defense
by Maj. Gen. Ben I. Funk, USAF 68

Science Boosts Ballistic Missiles
by Simon Ramo 76

Second Annual Encyclopedia of U.S. and Russian Missiles 106

A complete review, including photographs, drawings, specifications, and manufacturers where available. Special contents page 105

columns

Missile Week 43

Soviet Affairs 84

departments

Guest Editorial 7

Industry Countdown 44

Contract Awards 78

Moscow Briefs 89

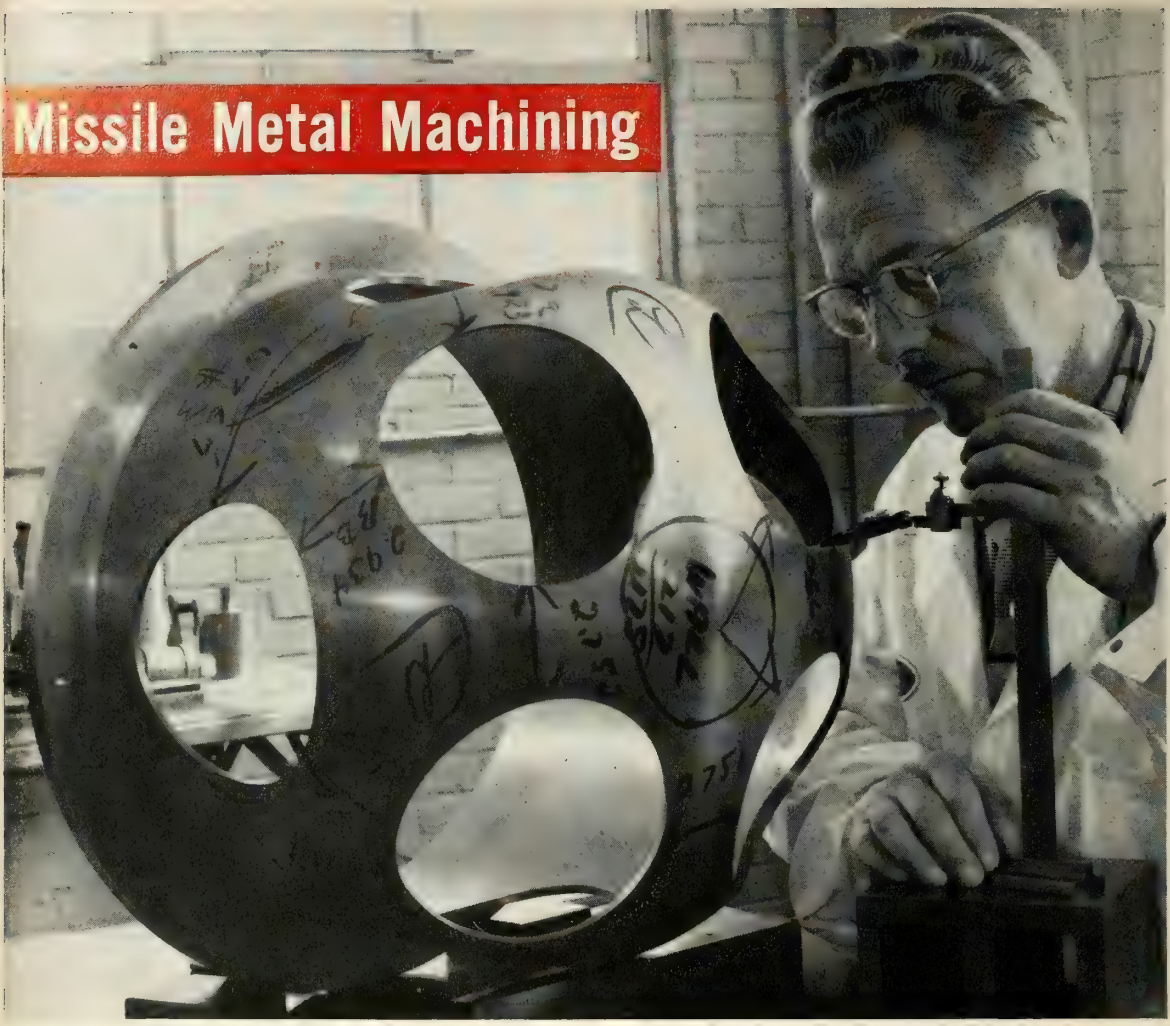
New Products 96

Missile Electronic News 151

When and Where 157

the cover

The barking end of a bird that's ready for business—an operational Lacrosse missile on its field launcher getting a final check-out by troops before brief combat countdown. Lacrosse was designed by Cornell Laboratories, is manufactured by Martin-Orlando and is now in service with the U.S. Army. Though not fancy, it's a practical, high-precision pill-box getter that features greatly simplified, reliable operation in the field and is therefore a good example of engineering progress in missilery. One example of the operational simplicity of Lacrosse is the fact that its "go, no-go" box is no bigger than a "creepy-peepy" and can be carried back-strap by one man. Another feature is its wholly mobile, air-transportable launcher and trailer system. It proves: simplicity pays.



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Knowledge, Key To Space Progress

The extent of our penetration of space in the next few years, using instrumented and man-carrying craft, will depend in large measure upon how effectively we utilize knowledge already in hand, and upon how hard we work to reach the far-flung goals we have set. Except for the enormous progress made in the past 55 years toward solution of the problems of flight, we would be little closer to the exploration of space than the dreamers of early times.

Space flight requirements impose new and very difficult demands upon our technology. What is mainly required is raising to new, very high levels, our competence in propulsion, structures, and guidance and control. It may be over-simplification, but not over-statement, to say that what we must do to move into space compares to the technological advances which made possible the past transitions from wood-and-fabric to all-metal airplanes; from reciprocating to turbojet engines; from subsonic to supersonic speeds; and from low-level to high-altitude pressurized flight. Each of these remarkable gains in performance became possible because of the contributions of many men, working in many scientific and engineering disciplines.

For the future, we already see the need for new types of engines—nuclear-powered rockets, ion jets, and others. To develop these to a state of usefulness will require large effort, and years to accomplish. There is, however, no need for us to wait for the new engines. Our "conventional" rocket engine can be enlarged very substantially, and a rocket engine with a million pounds of thrust can be most quickly attained by use of a cluster of rockets, each producing several hundred thousand pounds. Nevertheless, development of the larger engine should be undertaken promptly.

Congress has already approved legislation creating a National Aeronautics and Space Administration, with prospects of early adoption. This move closely follows the recommendations of the President, upon the advice of able scientists led by Dr. James R. Killian Jr., for vigorous prosecution of our national space program by a civilian agency based on the NACA staff and facilities.



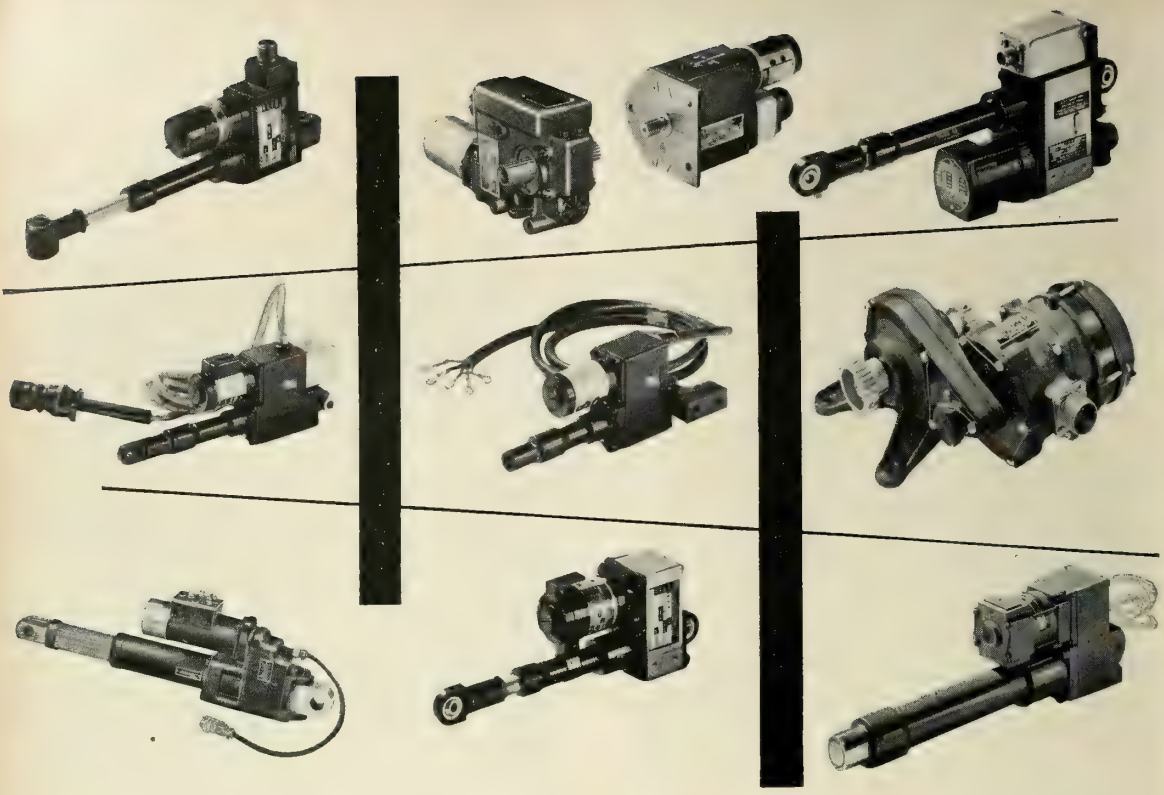
Since World War II the NACA has been engaged increasingly in research applicable to the problems of space flight, and at present nearly 50% of NACA's effort is applied in these areas.

To sum up, there are many problems common to aeronautics and astronautics, particularly those arising within the atmosphere on takeoff and during re-entry and recovery. There will be many other problems, some new and some old, such as guidance, communication, and new power sources.

No existing agency has within it all the skills and resources needed. There are no experienced astronautical engineers. Fortunately, there are scientists and engineers experienced in rocketry, aerodynamics, guidance, communications, structures, and human factors. These are the men who will have to solve our space flight problems.

Much of the activity of the NASA will be accomplished by a greatly expanded contract research program to obtain assistance from groups with special competence in specific areas. The course we will need to follow in moving into space is quite clear and straightforward. How fast and how far we go, in the last analysis, will depend upon the wishes of the 170 million citizens of the United States.

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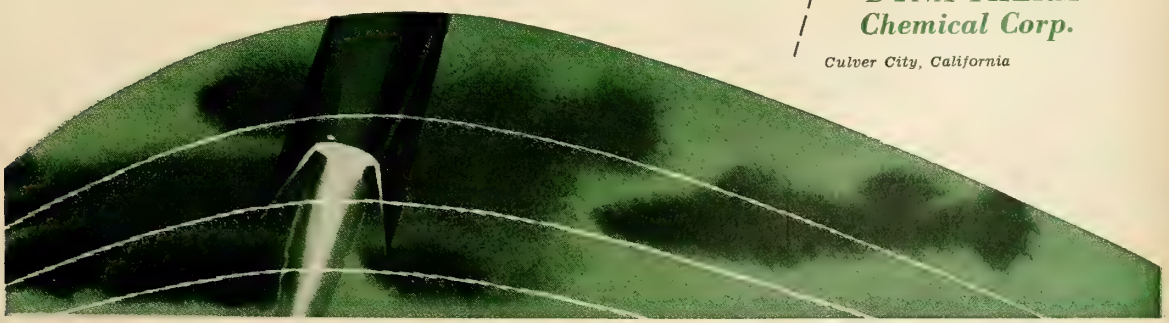
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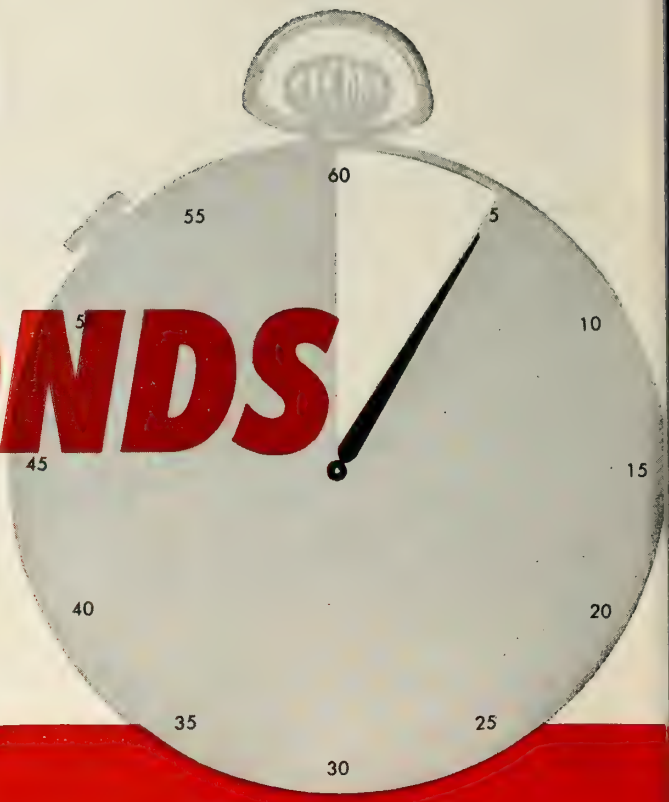
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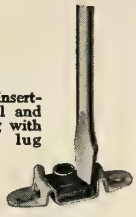
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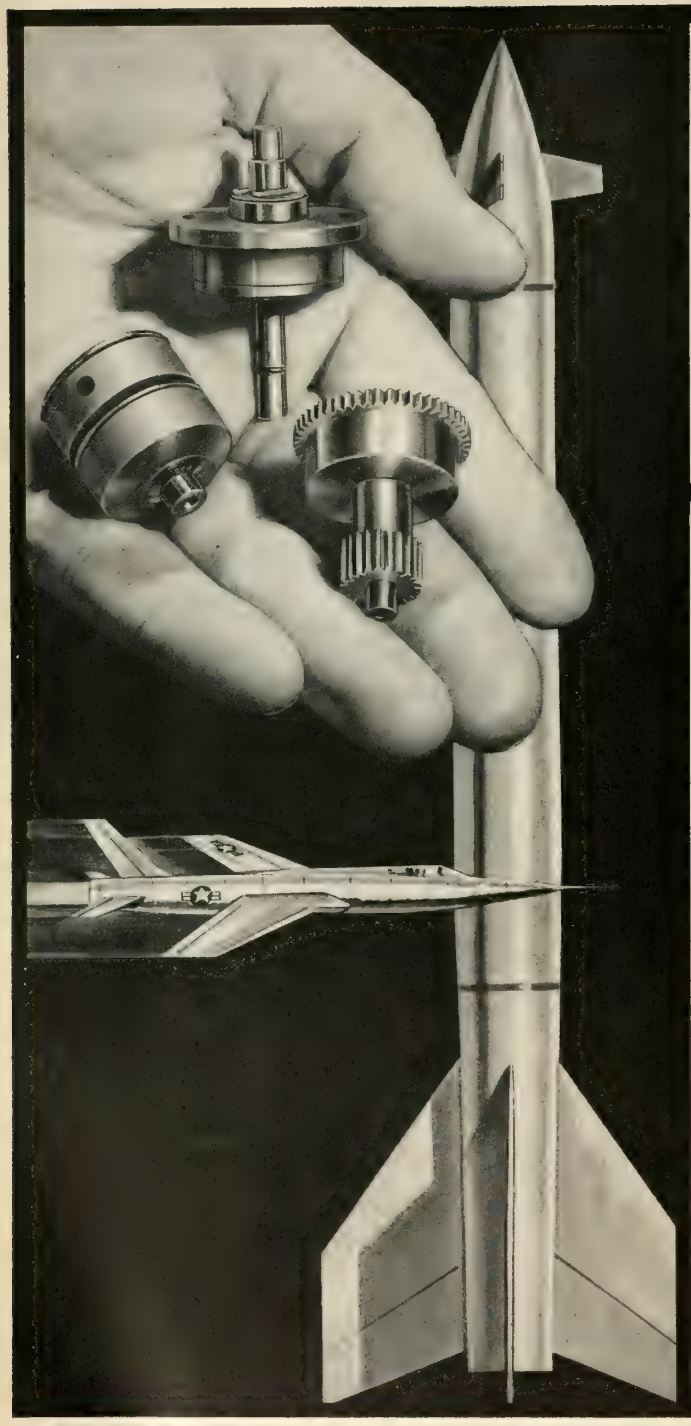
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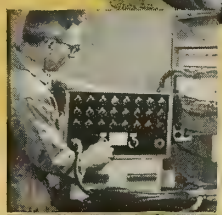
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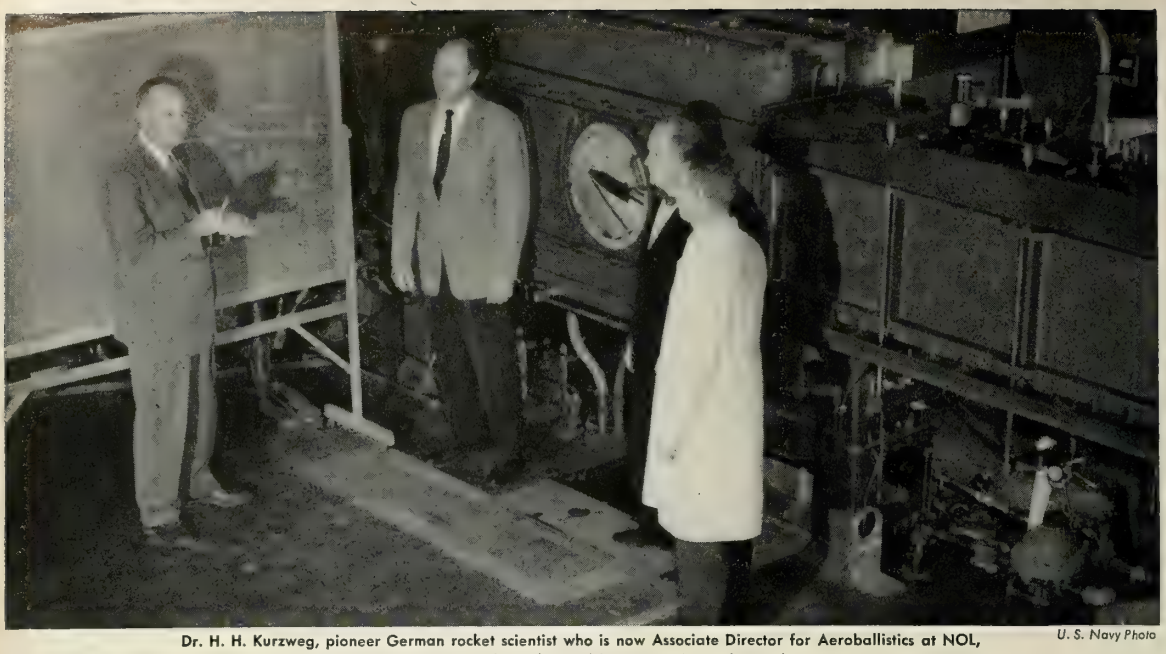
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Dr. H. H. Kurzweg, pioneer German rocket scientist who is now Associate Director for Aeroballistics at NOL, interprets nose-cone data obtained in supersonic wind tunnel test.

U. S. Navy Photo

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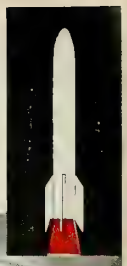
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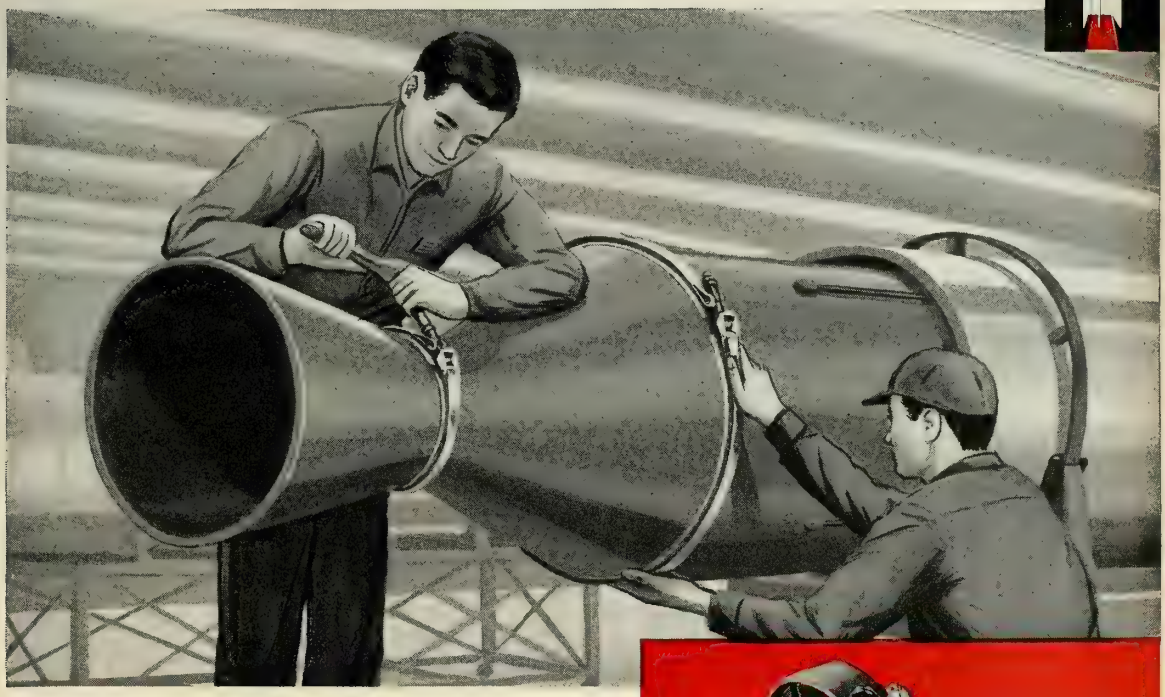
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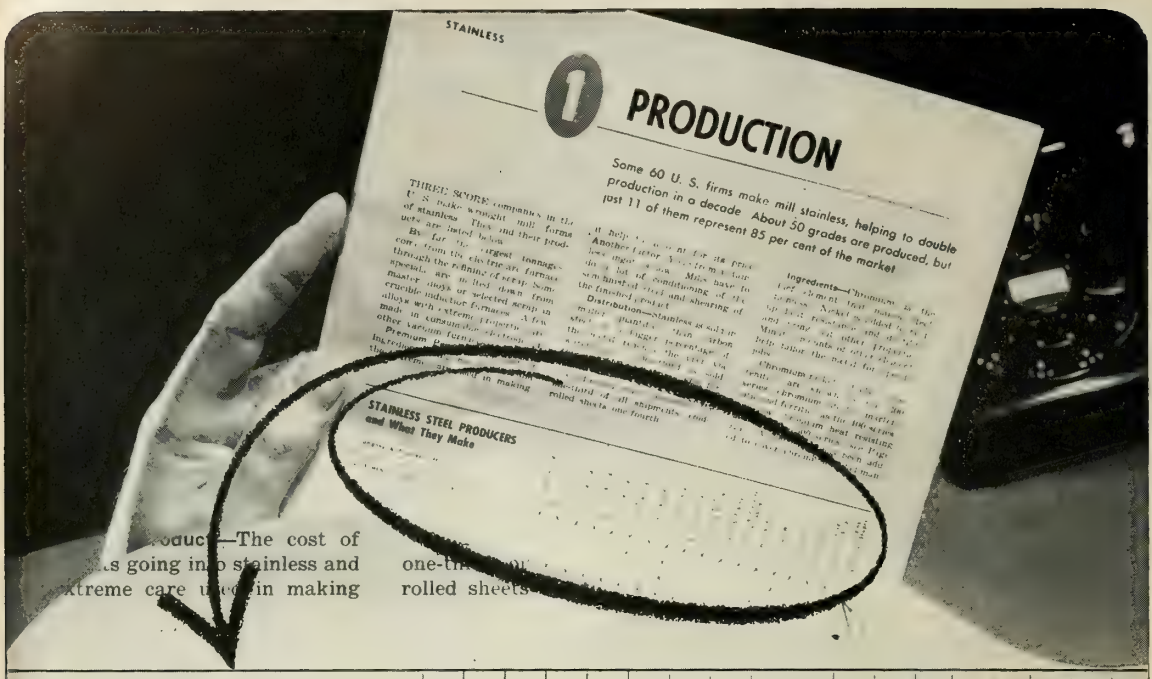
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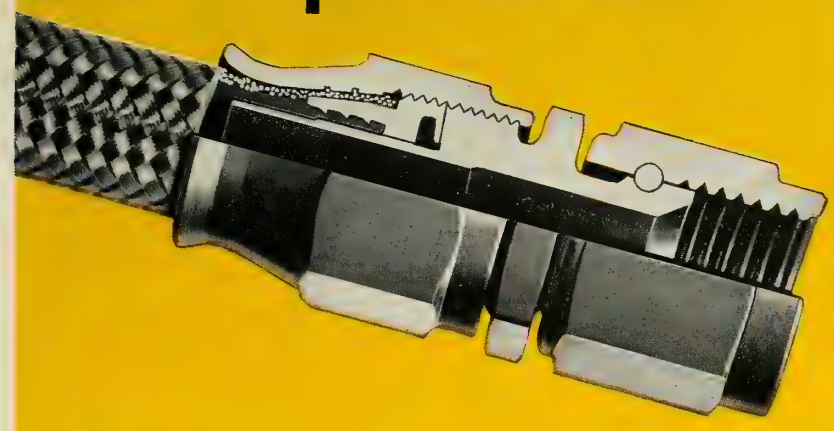
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EVERY FORM OF STAINLESS . . . . EVERY HELP IN USING IT

SEAL-LOCK*

...THE TRULY REUSABLE FITTING FOR FLUOROFLEX®-T HOSE

Triple-locked



Positively leakproof



A Threaded lockring grips braid tightly; buried, it's tamper-proof.

B Before tightening—nipple about to contact coned disk of lockring.

1 Tightened . . . spring action of coned disk locks threads in compression

2 Male threads are securely wedged against flanks of female thread

3 Radial displacement of coned disk presses rim against socket wall.

Superior design gives this reusable fitting the same iron-clad safety and reliability as the service-proved Resistoflex factory-swaged fitting. The unique coned disk lockring provides a triple lock when nipple is tightened... the fitting *cannot* leak, *cannot* blow-off.

Seal-Lock fittings are specially designed for fluorocarbon hose. Their reliability is assured by the company with the greatest experience in fluorocarbon hose production. They're CAA approved. Send for bulletin giving full data. RESISTOFLEX CORPORATION, Roseland, N. J.

*Trade Mark Pat. applied for.
®Fluoroflex is a Resistoflex trademark, reg., U.S. pat. off.

Originators of high temperature fluorocarbon hose assemblies

Resistoflex

CORPORATION

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NEWEST ADDITION TO RAYTHEON "CITY"

Increases company's engineering space to 903,000 sq. ft.

Raytheon's brand new laboratory at Santa Barbara, California, is devoted to advanced engineering in radar, countermeasures, communications, infrared. It's another extension of Raytheon "City"—the booming electronics community that has grown from Massachusetts to Tennessee to California.

Here are the company's vital statistics:

POPULATION: 3,000 scientists and engineers; 31,000 employees in all.

BUILDINGS: 26 plants and laboratories.

WORK AREA: 903,000 square feet of engineering space; 4,104,827 square feet of total space.

ACTIVITIES VITAL TO NATIONAL DEFENSE: Missiles—Navy Sparrow III and Army Hawk; bombing radar for the B-52; DEW line radar; tubes, transistors; magnetrons, amplitrons, klystrons and backward wave oscillators.

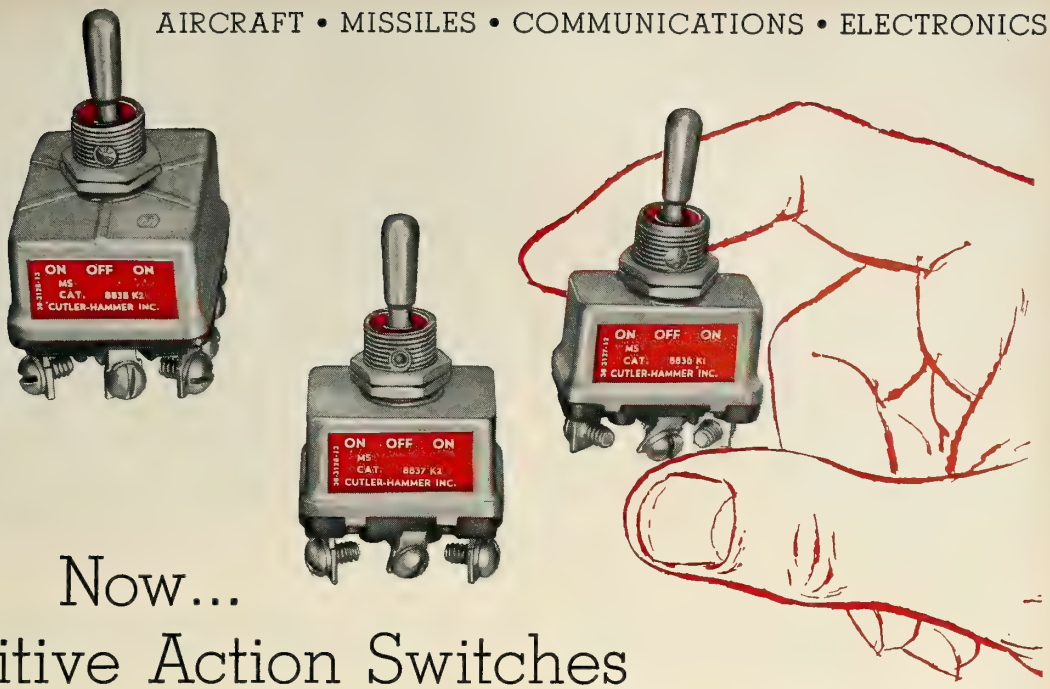
REPUTATION: World-wide.

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Excellence in Electronics

RAYTHEON MANUFACTURING COMPANY
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Now... Positive Action Switches ...another first from Cutler-Hammer

Now, after six years of intensive research, testing, and development, Cutler-Hammer offers another Cutler-Hammer *first* . . . a positive action toggle switch. Cutler-Hammer Positive Action Switches are new from toggle to terminals . . . new in design, new in construction, and new in performance and lasting dependability.

Here is the *first* switch with positive-make wiping contact action . . . the perfect control for very low energy circuits. And the positive-break switching action provides safe, reliable control of high energy circuits. Here is the *first* toggle switch where the contacts can be opened and closed independently of any spring pressure. Here is the *first* completely sealed, environment proof switch. All of these *firsts* plus the many other important improvements make these Cutler-Hammer Positive Action Switches *must* components whenever and wherever dependable electrical circuit control is important.

Cutler-Hammer's single, double, and four pole Positive Action Switches provide unlimited circuit combinations and are available in either standard or environment proof enclosures. For detailed information, write today for Publication EA-168.

CUTLER-HAMMER Inc., 1234 St. Paul Ave., Milwaukee 1, Wis.

CUTLER-HAMMER
AIRCRAFT CONTROL
C-H

These advanced features of design guarantee dependable performance under *all operating conditions:*

- Wiping contacts insure perfect switching for very low energy circuits
- Positive-break action insures safe, reliable switching with high energy circuits
- Direct toggle-to-contact mechanism guarantees switching action
- First totally enclosed, environment proof toggle switch
- 1° lever throw opens circuit
- Positive detent action prevents switch teasing
- New insulating material gives 3 times greater arc tracking resistance
- Greater terminal clearance for easier wiring
- Improved bushing seals are molded in place

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Advanced missile and space projects

require Engineers

and Scientists to work on

THE FRONTIERS OF SPACE

Lockheed Missile Systems Division, recently honored at the first National Missile Industry Conference as "the organization that contributed most in the past year to the development of the art of missiles and astronautics," holds such important, long-term projects as the Navy Polaris IRBM, Earth Satellite, Kingfisher (Q-5) target missile for the Army and the X-7 ramjet test vehicle for the Air Force.

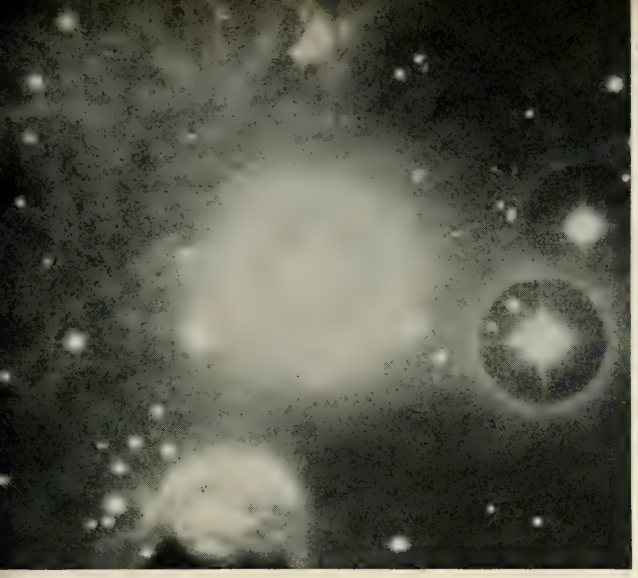
To carry out such complex projects, the frontiers of technology in all areas must be expanded. High-level engineers and scientists are needed now for responsible positions in our Research and Development laboratories and in our project organizations.

If you are experienced in physics; mathematics; chemistry or one of the engineering sciences, your inquiry is invited. Please write Research and Development Staff, Sunnyvale 7, California. (For the convenience of those living in the East and Midwest, offices are maintained at Suite 745, 405 Lexington Ave., New York 17, and at Suite 300, 840 N. Michigan Avenue, Chicago 11.)

Lockheed / MISSILE SYSTEMS DIVISION

SUNNYVALE • PALO ALTO • VAN NUYS • SANTA CRUZ • COOKE AIR FORCE BASE, CALIF. • CAPE CANAVERAL, FLORIDA • ALAMOGORDO, NEW MEXICO

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ECHNOLOGY



FLIGHT IN THREE MEDIUMS

Several things set the Polaris apart from other outer space weapons in the ballistic missile category, for the Polaris program involves a wholly new concept of weaponry.

1. It will be dispatched from beneath the surface of the sea.
2. It will be radically smaller than currently developed land-launched missiles, yet its payload will be as effective and its range the same as other IRBMs.
3. It will be the first operational outer space missile to employ solid fuel as a propellant.
4. It will travel through three mediums in a single flight—water, air and outer space.
5. Its launching base—a submarine—is not fixed but a mobile vehicle.

OUTER SPACE PROGRAM

Very little can be said about the Earth Satellite program at this time except that its success will necessitate advancing the state of the art in all sciences.

The Earth Satellite Project is perhaps the most sophisticated outer space program to reach the "hardware" stage in the U.S. today.

ENEMY SIMULATOR

The Lockheed Kingfisher Q-5 is the nation's fastest target missile, developed for the Air Force to test the accuracy of our newest supersonic weapons.

It is a ramjet target vehicle with Mach 2-plus capabilities. The Q-5 not only has speed to match the defensive missiles, but can also simulate a vast array of supersonic enemy missiles and airplanes attacking from great height. It is instrumented to score near misses and even theoretical hits without itself being destroyed.

It is recoverable from flight by parachute to be flown again, permitting weapon system evaluation to be conducted at greatly reduced cost.



NAVY'S NEW ATOMIC DEPTH BOMB ANSWERS THREAT OF ENEMY SUBS

THE NEWS THAT "BETTY" is now an operational weapon completes another chapter in the story of the Navy's great contributions to the defense of our country. And we are proud that the Navy Bureau of Ordnance and the Naval Ordnance Laboratory, White Oak, Silver Spring, Maryland, developers of this significant weapon, called upon the facilities of AMF for the production of "Betty". This is another demonstration of the fact that, when it comes to the tough jobs, AMF has experience you can use.

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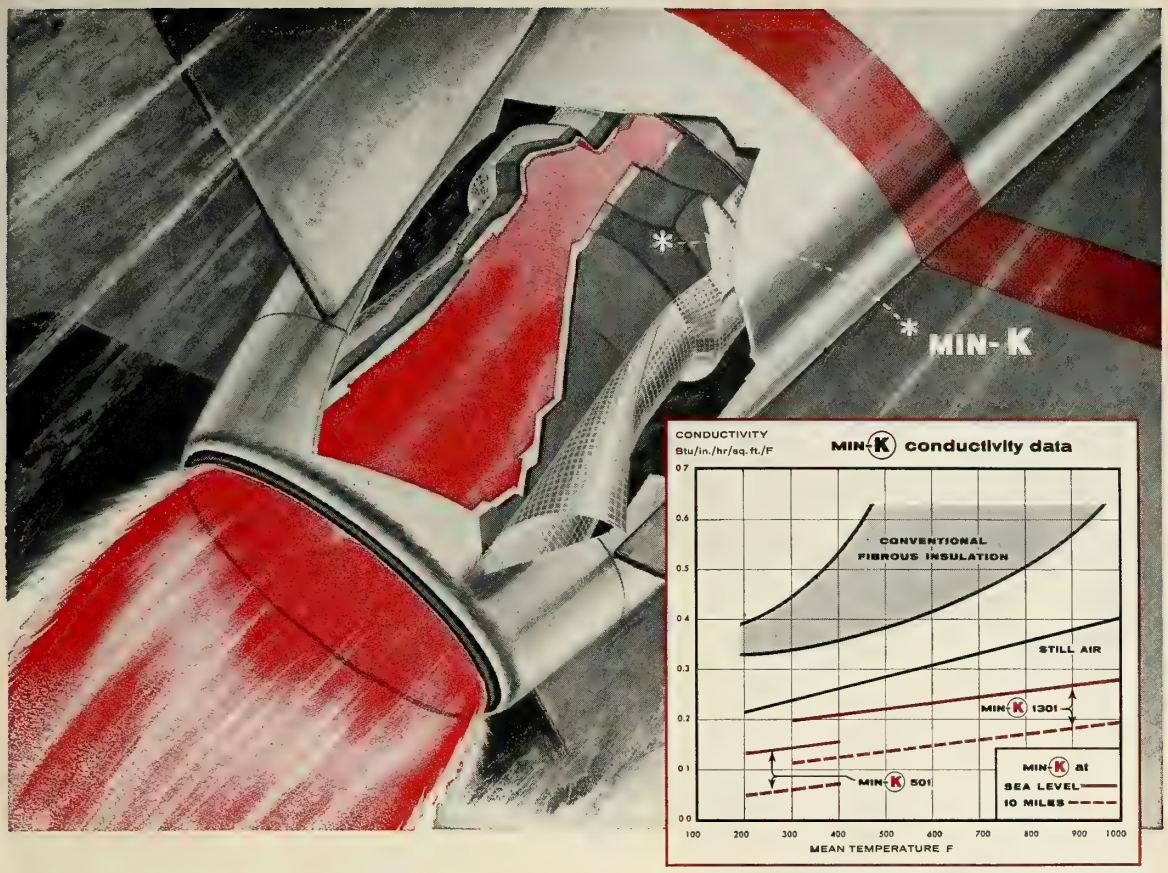


Chart compares Min-K's thermal conductivity with conventional fibrous insulations and still air. Note that Min-K's conductivity decreases with altitude.

Johns-Manville announces . . .

A scientific break-through in missile insulation!

New MIN-K has lower conductivity than still air—performs better the higher it flies

- **Saves missile space to boost fuel capacity and range**
- **Protects instrumentation more effectively to increase accuracy**
- **Offers lower thermal conductivity than any known insulating material**
- **Now performing successfully in operational U.S. missiles**

Min-K is in every meaning of the term —a scientific break-through!

For in Min-K, Johns-Manville research scientists have developed an insulating material entirely new in concept, an insulation so effective that its thermal conductivity is actually below what was long called the ultimate—the molecular conductivity of still air.

Increases accuracy and range

With this new low in thermal conductivity (less than half that of the best fibrous insulations), Min-K contributes to greater accuracy by providing more effective protection of temperature-sensitive instrumentation . . . increases range by conserving space for greater fuel storage.

Insulates better the higher it flies

Unique with Min-K is improved performance at altitude, for its thermal conductivity drops appreciably as atmospheric pressure decreases. At an altitude of 10 miles, for example, Min-K's thermal conductivity is decreased by as much as 40%, and further decreases at higher altitudes!

Manufactured by J-M as integral parts—Min-K insulations are precision molded to any shape you specify . . . encased in high-temperature metal foils or laminated to reinforced plastics. Min-K insulations include a wide variety of strengths, densities and temperature resistances.

For detailed information about Min-K, write Johns-Manville, Box 14, New York 16, N. Y. (Ask, too, for aviation insulation brochure IN-185A.) In Canada, Port Credit, Ontario.

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AIR FORCE – RE-ENTRY – X-17
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NOTABLE ACHIEVEMENTS AT JPL...



THE ARMY'S NEW SERGEANT

JPL is proud to have the responsibility of designing and developing the U.S. Army's newest operational missile system—the Sergeant. This weapon is America's first truly "second generation" surface-to-surface tactical missile and, when placed in production will eventually succeed the Corporal which was also a JPL development.

The Sergeant, especially designed as an extremely mobile tactical weapon, utilizes a solid propellant rocket motor which provides better field handling and storage capabilities than those of many other weapon systems. It can deliver a nuclear blow deep into enemy territory and its highly accurate guidance system is invulnerable to any known means of enemy countermeasure.

All elements of the Sergeant are particularly designed for active field use with emphasis on reliability, mobility and the use of standard U.S. Army vehicles wherever possible. The erector-launcher, for example, is capable of rapid movement over rough terrain. These characteristics place in the hands of the U.S. Army an important new tactical element of extended range.

The basic activity at JPL continues to be—research into all scientific fields related to the development of weapons systems and space research vehicles.

CAREER OPPORTUNITIES NOW OPEN IN THESE FIELDS

ELECTRONIC, MECHANICAL, CHEMICAL AND AERONAUTICAL ENGINEERING • PHYSICS AND MATHEMATICS

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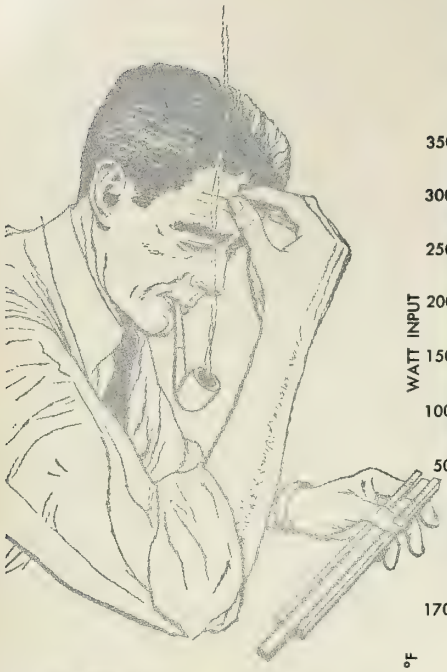
JET PROPULSION LABORATORY

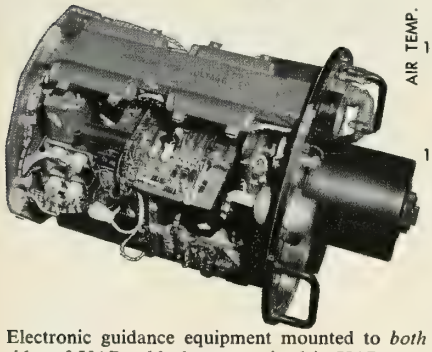
A DIVISION OF CALIFORNIA INSTITUTE OF TECHNOLOGY

PASADENA • CALIFORNIA

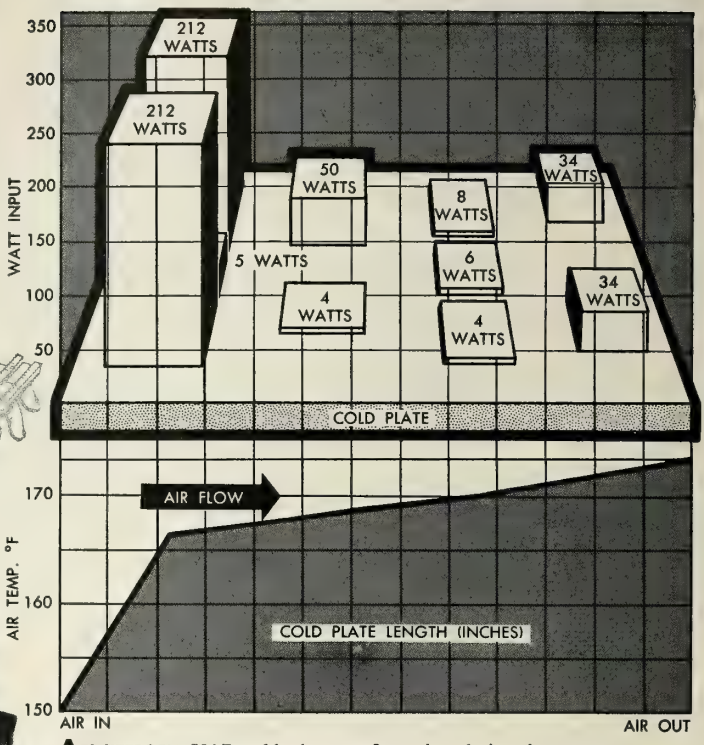
ELECTRONIC COOLING

Requirement: Stay within customer's envelope. Dissipate 569 watts thru 13 x 10 in. cold plate and not exceed a plate temperature of 173°F with cold plate air-in temperature of 150°F. Provide areas for circuits to be mounted to cold plate surface between power units.





Electronic guidance equipment mounted to *both* sides of UAP cold plate, contained in UAP pressurized case . . . for control of air-to-air missile.



Answer: UAP cold plate configuration designed to provide adequate heat transfer from localized high, medium and low heat concentration areas with air-in temperature at 150°F. All requirements met with room to spare.

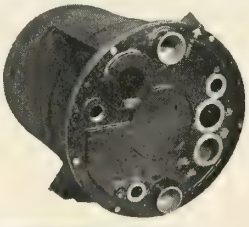
The hypothetical conditions as stated above are typical of the problems that have come to us since the advent of electronically controlled supersonic missions.

UAP eminence in the heat exchanger field has been firmly established over the years by delivery of systems and components of proved optimum performance and reliability. Our experience covers the engineering and production of devices for application as cold plates, gas-air heat exchangers, air-liquid heat exchangers, and associated controls; mechanical refrigeration systems and expendable refrigeration systems. These can function in the anticipated environmental conditions and utilize one or more of the following heat sinks; ambient air, expanded bleed air, expanded ram air, ram air, expendable refrigerant, or available liquid.

Make your requirements our responsibility. Call . . .

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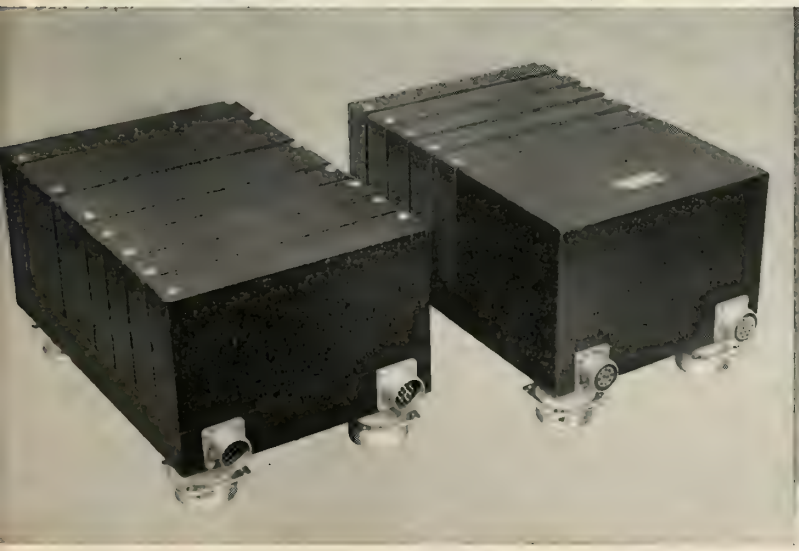
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AIRBORNE
DIGITAL



GEVIC a new concept in military airborne computers







SMALL—0.8 cu. ft.—LIGHT—45 lbs.—with speed and capacity to perform all computation functions for an advanced fighter-bomber—this is one version of **GEVIC**, General Electric's new variable increment digital computer. **GEVIC** is based on General Electric developments of new mathematical techniques and solid-state logic elements. For information on how **GEVIC** and other computer developments can benefit your aircraft, missile, or other applications, send for new LMEE brochure . . . "Computers . . . Abacus to Airborne." **Write Dept. 68**

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LIGHT MILITARY ELECTRONIC EQUIPMENT DEPARTMENT
FRENCH ROAD, UTICA, NEW YORK

A DEPARTMENT IN THE DEFENSE ELECTRONICS DIVISIO



Leading organizations in the aircraft and rocket industries look to L·O·F Glass Fibers Company for the new developments in both thermal and acoustical insulating components. They know this is *the only company in the glass fiber field* which performs all five of the following:

1. **Starts with the sand**
2. **Turns it into glass**
3. **Draws it into fibers**
4. **Forms them to specification**
5. **Covers them with metal, fabric or plastic in custom fabrication**

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There is a qualified engineer near you. Inquiries invited. Address Department 59-78.

L·O·F GLASS FIBERS

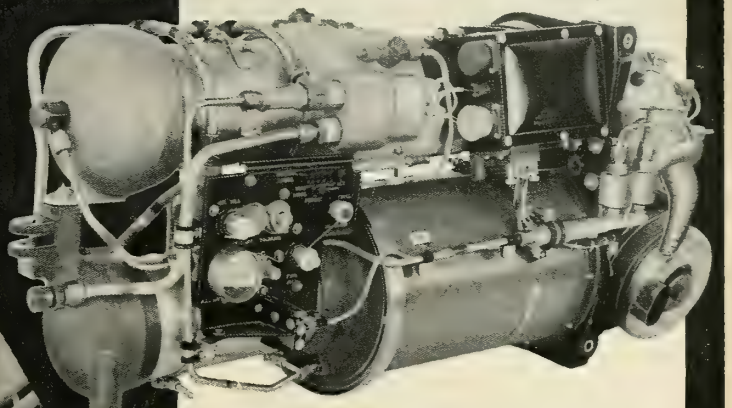
L·O·F GLASS FIBERS COMPANY

Pacific Coast Division
Van Owen Boulevard • Burbank, California

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AUXILIARY POWER for the U.S. Army's deadly NIKE HERCULES

AiResearch units power the controls of America's most potent defense weapons



Key defense and population centers are now being ringed with batteries of Army Nike Hercules missiles to deter or destroy aggressors. *Supplying power for flight controls* is the AiResearch auxiliary power unit pictured above, now in production.

As a member of the Army-industry team producing the Nike Hercules (Army Ordnance, Western Electric-Bell Telephone Laboratories and Douglas Aircraft), AiResearch was chosen to design, develop and manufacture this vital accessory power source for the missile because of nearly two decades of experience in lightweight turbomachinery.

This experience includes applications utilizing solid propellants, liquid mono-propellants, bi-propellants, atomic power, cryogenic gases as well as gasoline and air. AiResearch's ability for high capacity production as well as in research and development, made it the logical choice.

Garrett's AiResearch divisions have also designed systems and components for 18 other missiles and rockets in the U.S. defense arsenal.

We invite your inquiries.

ENGINEERING REPRESENTATIVES: AIRSUPPLY AND AERO ENGINEERING, OFFICES IN MAJOR CITIES

THE GARRETT CORPORATION

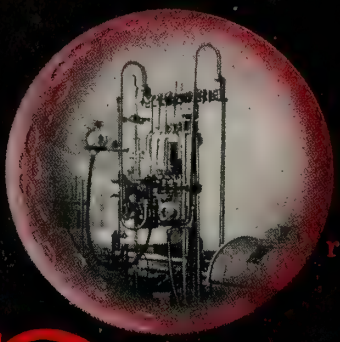
AiResearch Manufacturing Divisions

Los Angeles 45, California • Phoenix, Arizona

Systems, Packages and Components for: AIRCRAFT, MISSILE, ELECTRONIC, NUCLEAR AND INDUSTRIAL APPLICATIONS

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formula for
the space age...



research

r & d + p =

SUNDSTRAND TURBO



development



production

one example:

quantity production
of accessory
power systems

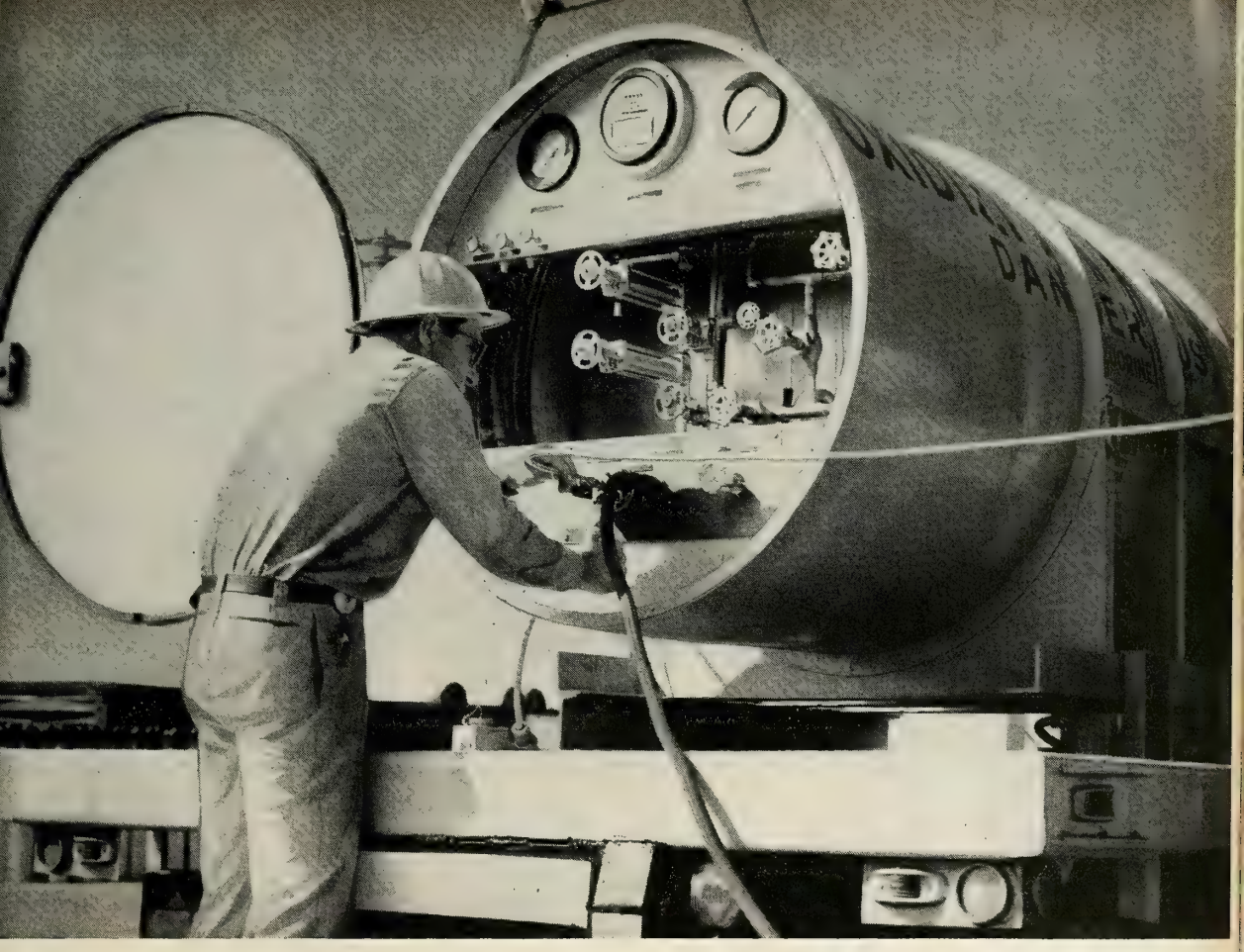
Picture a Research & Development staff of the country's foremost experts in accessory power for guided missiles...the most advanced environmental test facilities available anywhere for hot-gas firing of APS and other space-borne components...200,000 square feet of precision manufacturing facilities...picture these, and you're looking at a dynamic *single-source* of talent and tools offered prime and sub-contractors in the nation's space program—Sundstrand Turbo.

Write for "FACILITIES & CAPABILITIES OF SUNDSTRAND TURBO"

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A division of SUNDSTRAND MACHINE TOOL CO.



TAMED: *the elemental fury of fluorine!*

Still thinking of elemental fluorine as "too hard to handle"? Not any more! As a result of General Chemical research, this "optimum" oxidizer can now be stored, transported and handled directly *as a liquid* in tank-truck tonnages. If you are interested in working with fluorine as an oxidizer for rocket fuels, or for any other application, this development could be of major importance to you.

Benefits of liquid fluorine. Now that fluorine is available in liquid form and in bulk quantities, you can handle and store it more easily, more safely and more economically than ever before. An important *plus* value—the shipping containers can also be used as storage tanks.

Halogen fluorides also available. The halogen fluorides, too, are commercially available from General Chemical. Chlorine trifluoride is available in ton cylinders and cylinders of 150 lbs. net. Bromine trifluoride, bromine pentafluoride and iodine pentafluoride are offered in various-sized cylinders to suit demand.

Write for free technical bulletins. A comprehensive new technical bulletin, "Fluorine," will be sent you on request. Also Technical Bulletin TA-8532-2, covering Chlorine Trifluoride and other Halogen Fluorides. Write for your free copies today.

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First in Fluorine Chemistry

GENERAL CHEMICAL DIVISION

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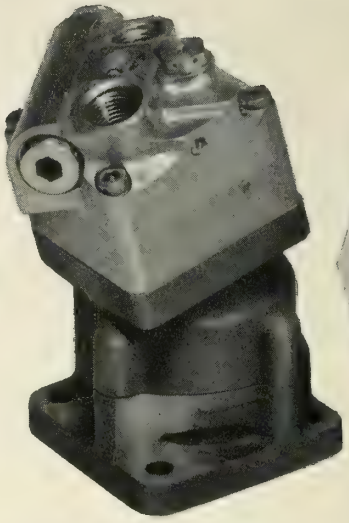
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FOR AIRCRAFT AND MISSILE APPLICATIONS:

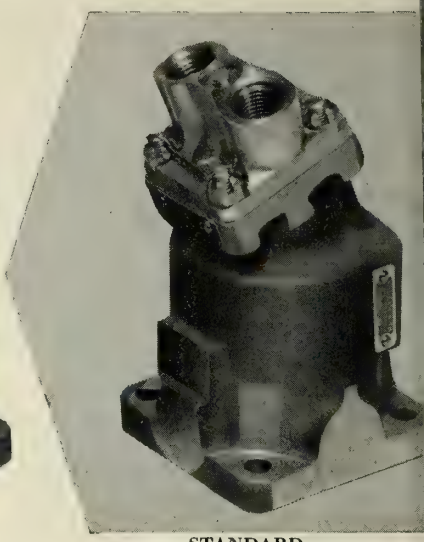
Variable Pump Design Breakthrough!

...by VICKERS

Variable hydraulic output from constant displacement package



NEW MINIATURIZED
VARIABLE DISPLACEMENT
3906 Series ■ Weight...2.4 lb



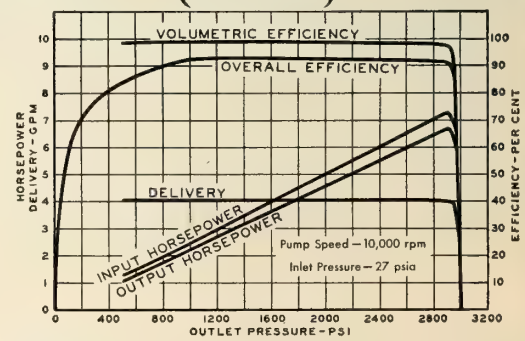
STANDARD
CONSTANT DISPLACEMENT
3906 Series ■ Weight...2.1 lb

- 48% weight reduction—70% smaller envelope*
- 12,000 rpm for aircraft applications
- 18,000 rpm for missile use
- 24,000 rpm for intermittent duty
- 9.7 gpm delivery at 24,000 rpm
- 17 hp (over 7 hp/lb) at 24,000 rpm and 3000 psi
- 98% volumetric efficiency—92% overall efficiency
- Uses proven Vickers 3000 psi rotating pumping element
- Integral automatic pressure compensator
- Extremely rapid response
- Minimum external sealing elements
- Minimum number of moving parts*
- Broad range of control methods available
- First of a new complete line
- Power saving (and heat rejection) advantages of variable displacement at fixed displacement weight and envelope.

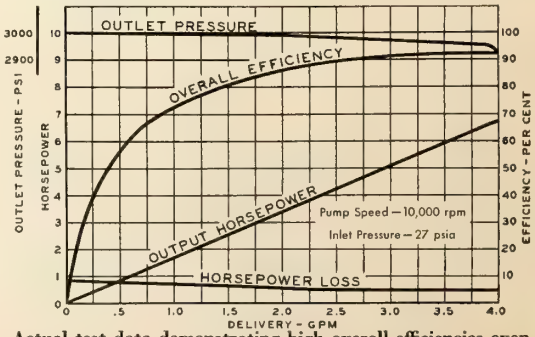
*Compared to standard 3000 psi Vickers Series PV-3906 variable displacement axial piston pump.

For further information write for Bulletin No. A-5233.

Performance Characteristics of Model E-0011111 Pump
(PV-3906 -30° Size)



Curves above show actual performance of new Vickers variable delivery pump. Note exceptionally high volumetric and overall efficiencies throughout broad outlet pressure range.



Actual test data demonstrating high overall efficiencies even at partial flows for the new Vickers variable delivery pump. Note low horsepower loss throughout entire delivery range.

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HOW SCATE SOLVES 2 BASIC PROBLEMS in testing electronic systems

Many complex electronic systems—missile guidance is a good example—may require testing that takes days by conventional methods. Yet the end function of such a system may last only a few minutes—**even seconds.**

Other systems, though less complex, must be tested in such large numbers that adequate personnel are frequently unavailable to perform tests by conventional means.

The SCATE system of automatic test equipment can solve **both** problems. It provides **self-checking** automatic testing which is **fast, flexible** and **foolproof.**



The system evaluates all important parameters of equipment under test, including:

1. RF sensitivity, center frequency, band width, power output, noise figure.
2. Audio frequency gain, band width, power output.
3. Video pulse circuitry, including pulse decoding, logic, digital comparison, pulse delays.
4. Voltage levels, DC and AC.
5. Servo response.
6. Mechanical response.

Stromberg-Carlson has standing designs for all the standard components which go into a SCATE system, and is fully experienced in designing custom components which may be required in any test system.

Complete details on the SCATE system and other Stromberg-Carlson automatic test equipment are available on request.

* Missile guidance system can be tested automatically by the SCATE system.

"There is nothing finer than a Stromberg-Carlson"

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A DIVISION OF GENERAL DYNAMICS CORPORATION
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train with ERCO devices

The human factor becomes proportionally more critical as the operation of modern weapons and industrial control systems becomes more complex.

"Short term" military personnel responsible for operating multi-million dollar defense equipments, must be brought to the highest degree of training in the shortest possible time. This "Man-Machine" link is critical to our national defense — and to be prepared we must be in a position to Effectively Activate* the complex systems being designed and delivered.

These ERCO "Human-engineered" training devices are designed to safely, quickly, economically, and efficiently bring about proficiency in operators at all levels of experience. With our outstanding contribution in the field of simulation as background we are meeting new training requirements as they arise . . . providing sound, realistic training devices to government and industry.

Write today for "The Man-Machine Data Link," ERCO Plant Nuclear Products — ERCO, division of ACF Industries Incorporated, Dept. MT, Riverdale, Md.

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NUCLEAR PRODUCTS – ERCO, DIVISION OF ACF INDUSTRIES, INC., RIVERDALE, MARYLAND

AMERICAN CAR AND FOUNDRY
ADVANCED PRODUCTS
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THE NEW LIGHTWEIGHT A-MP "240" PATCHCORD PROGRAMMING SYSTEM

. . . means lightning fast in-flight reprogramming of airborne electrical/electronic circuitry . . . obsoletes fixed circuit connectors and other systems requiring hours or days to rewire . . . and offers these unusual features:

- removable patchboards to permit complete reprogramming in seconds
- 3¼ pounds to minimize weight . . . miniaturized to conserve space
- rugged shock and vibration-resistant construction with high strength aluminum alloy
- shock-resistant seating of patchcord plugs in removable board
- AMP's patented wiping action that pre-cleans contacts for top electrical performance
- 240 contacts for greatest versatility in circuit combinations or program arrangements

For more information on this new airborne wiring technique, AMP's Patchcord System Catalog is available on request.

AMP INCORPORATED

GENERAL OFFICES: HARRISBURG, PENNSYLVANIA

A-MP products and engineering assistance are available through wholly-owned subsidiaries in: Canada • England • France • Holland • Japan

Circle No. 33 on Subscriber Service Card.

NEWS FROM FLEXONICS

DUCTING AND COMPONENTS ENGINEERING BRIEFS

One of a series of reports to help you make more effective use of Flexon products.

FLEXIBLE CONNECTORS WITH FLEXIBLE LINERS

for minimum turbulence and minimum pressure drop

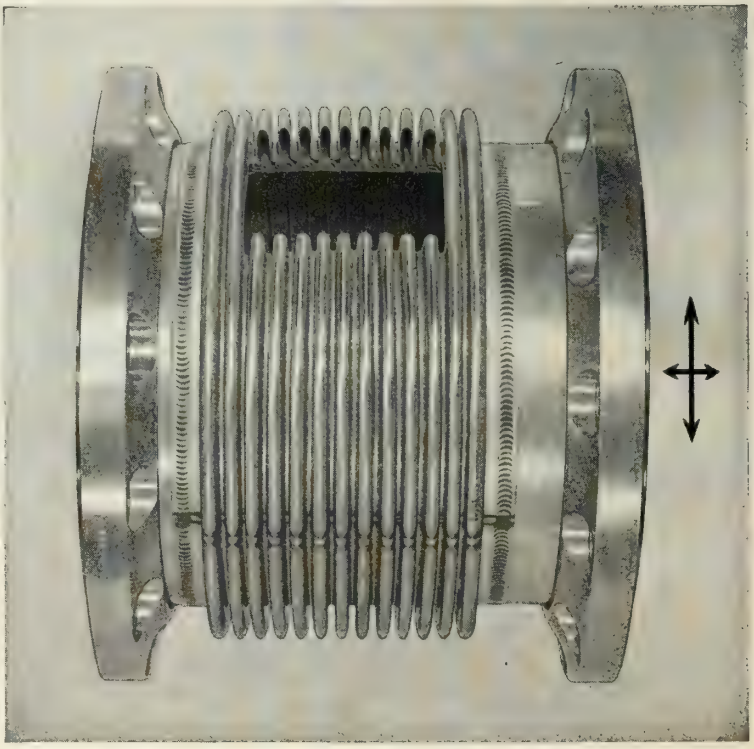
One of the critical problems in plumbing design for advanced aircraft and missiles is that of handling difficult liquid and gaseous media. Undesirable turbulence and pressure drop are often encountered when using conventional flexible connectors.

Flexonics has solved this problem with the development of a new lined connector assembly. Utilizing a conventional corrugated stainless steel section as pressure carrier, a smooth bore flexible liner has been added.

The liner is a specially developed interlocked flexible tubing formed from stainless steel strip in such a manner as to provide a smooth inner surface. The liner is welded into the pressure carrier assembly to prevent displacement under extreme conditions of flexure and vibration.

The liner itself is relieved so that it carries none of the pressure. The pressure capacity of the unit is entirely dependent on the corrugated member.

Specially designed interlocked construction of the liner does not reduce the ability of the unit to absorb the axial motion for which it has been designed. Because the liner itself is flexible, the entire unit permits substantial offset motion as well.



Flexon lined flexible connector cut away to show inner construction. The flexible liner substantially reduces turbulence created in the connector and minimizes pressure drop through the unit.

Advantages of the Unit

In liquid oxygen lines where the new Flexon lined connectors are being widely used, it has been found that the reduced turbulence provided by the liner minimizes cavitation in centrifugal pumps. The advantages of reduced pressure drop in the delicately balanced fuel system of a missile are obvious.

Weight is kept to a minimum through the use of thin wall high strength, corrosion resistant alloys. Excellent fatigue life of Flexon corrugated flexible connectors has already been proved in thousands of operational units.

Engineering Assistance

Whenever you have a problem involving aircraft or missile piping or ducting, take advantage of Flexonics Corporation's experience and facilities. The engineering skill of Flexonics Corporation is proved by scores of developments already in successful service, ranging from single flex connectors to entire aircraft ducting systems.

Backing up this engineering skill are test facilities second to none. The Flexonics laboratories are capable of the most advanced testing techniques and procedures for proving assemblies before installation in aircraft, engines and missiles.

If you have a specific problem involving ducting or piping, send an outline of your requirements and Flexonics Application Engineers will be pleased to make recommendations.

For factual data right at your finger tips, write for information on how to secure your copy of the Flexonics Engineering Manual.

Flexonics *Corporation*

AERONAUTICAL DIVISION
A-40

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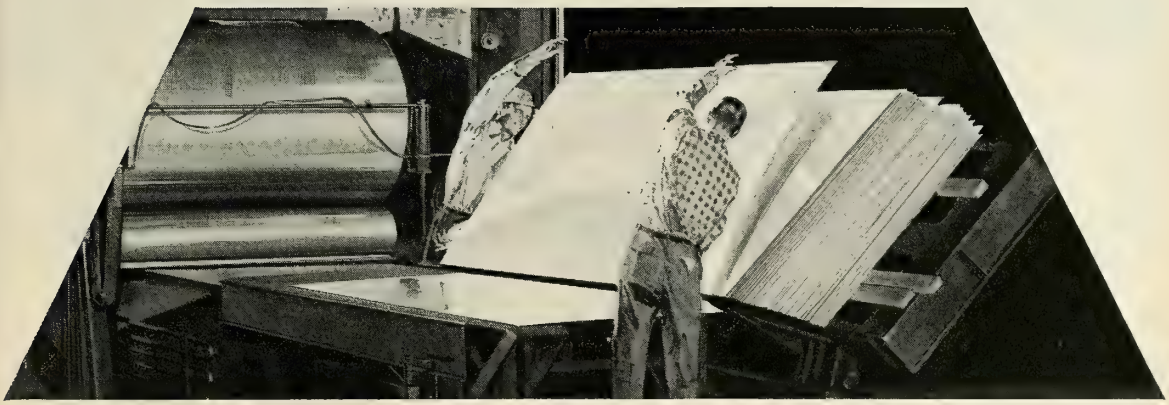
In Canada: Flexonics Corporation of Canada, Limited, Brampton, Ontario
Also Manufacturers of Rubber and Metal Hose Assemblies • Metallic Bellows • Expansion Joints

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Udimet 500

a vacuum induction melted alloy

NOW AVAILABLE IN SHEET...



Udimet 500, a superior alloy proven by extensive high temperature applications, is now available in sheet in production quantities for early delivery. It is produced in widths to 48″ by 144″ in length and in thickness down to .010″. The alloy combines very high stress rupture life with excellent ductility and fatigue resistance in the 1200°F to 1800°F ranges.

Many other vacuum induction melted alloys are also now marketed in sheet form by the Utica Metals Division.

New alloys are being developed at Utica for critical sheet application. We are interested in discussing uses for our sheet material where high tensile strength, corrosion resistance, high stress rupture life and electrical or magnetic properties are critical requirements.

The technical strength and experience of our organization, together with highly precise melting and inspection practices, enable us to guarantee absolutely consistent quality from heat to heat. Utica Metals Division, Kelsey-Hayes Co., Utica 4, N. Y.

UTICA METALS DIVISION OF **KELSEY-HAYES**

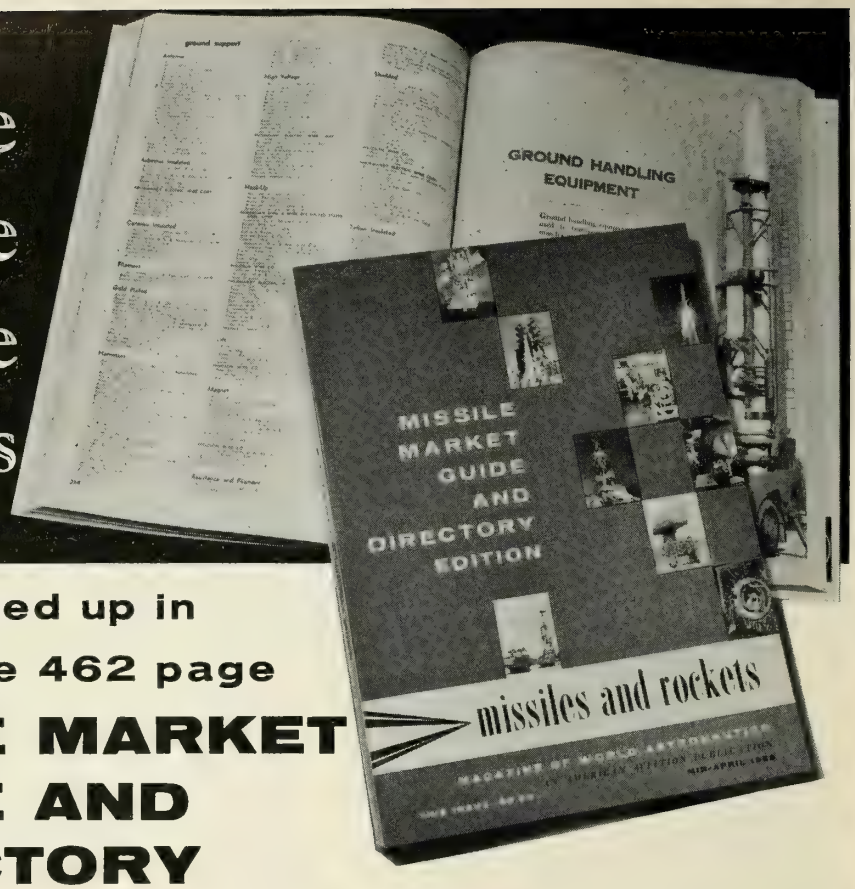
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SOME ALLOYS COVERED BY U.S. PATENT #2809110

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Here is the Missile Business



All wrapped up in one valuable 462 page

MISSILE MARKET GUIDE AND DIRECTORY

NEED an idea, a system, a component, a small part or complete buying information about the missile business? Somewhere in the pages of the MISSILE MARKET GUIDE AND DIRECTORY are all the key companies that can supply this valuable information.

The Missile Business is a burgeoning industry. Its rate of growth has been extremely rapid, but it's nothing compared to what's in store. In less than a decade, the "missile market" has rocketed from practically nothing to over $3.5-billion today, prospects of $7-billion in another three years and some $20-billion or more by 1970—for military purposes alone.

MISSILE AND ROCKETS' **MISSILE MARKET GUIDE AND DIRECTORY** contains over 76,000 company products listings. Over 3,000 companies are named.

The MISSILE MARKET SURVEY includes articles on how to do business with the—

—Department of Defense,
—Department of the Army
—Department of the Air Force
—Department of the Navy

. . . PLUS a liberally illustrated directory of the missiles that stock the U.S. Missile Arsenal listed by name, type, service and status and gives prime contractor, principal subcontractors and associate contractors.

The 70-page MISSILE PURCHASING DIRECTORY lists company name, address, phone number, and key purchasing and sales personnel of a supplier. The type of company activity is explained by coding at the end of each listing.

The MISSILE CATALOG product listings have been divided into the following nine major categories for the convenience of the user.

—Missile Frame
—Warhead and Nose Cone
—Propulsion Systems & Auxiliary Power Units
—Ground Support
—Ground Handling
—Guidance Equipment
—Checkout Equipment
—Test Equipment
—Tracking & Telemetering

You get 462 pages of accurate, illustrated data: (Size 8 x 11¼)

Order extra copies for yourself, your organization and your associates.

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Another Foote Bros. First—



Foote Bros. Transmission Selected for New HU2K Utility Helicopter

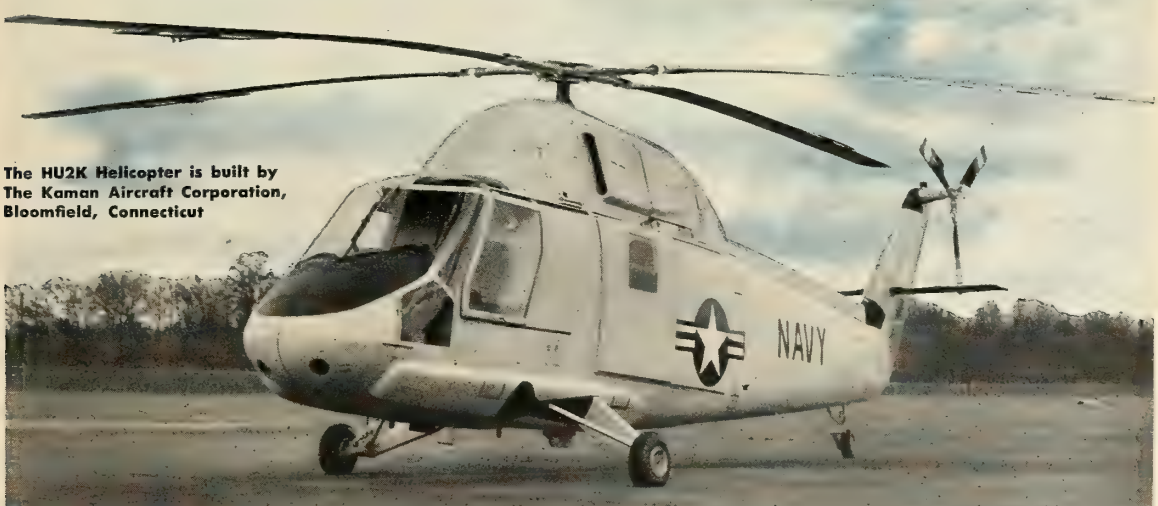


When the Navy's new HU2K Utility Helicopter "joins the fleet," it will be equipped with main Rotor Transmissions built by Foote Bros.—further evidence of the confidence placed in us and our ability to provide a vital component for still another important military weapon.

Here at Foote Bros., we believe that every contribution we can make toward the design, development and perfection of more efficient, more dependable components for our country's military capability is more than just good business; it is an obligation and a trust we are privileged to bear.



If your problem involves any phase of power transmission . . . if you require the highest quality precision gearing or actuating mechanisms for aircraft, engines, or missiles, come to Foote Bros. first. Here you will find the experience, skill, facilities, and high traditions of a proven partner to the aviation industry.



The HU2K Helicopter is built by The Kaman Aircraft Corporation, Bloomfield, Connecticut



this trademark stands for the finest industrial gearing made

FOOTE BROS.

Better Power Transmission Through Better Gears

FOOTE BROS. GEAR AND MACHINE CORPORATION

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a new small, powerful, light-weight

MOTOR for MISSILES

an outstanding advanced design

...by EEMCO



EEMCO MOTOR TYPE D-1026

This motor, of advanced design, for various applications in missiles is only 3-15/16" x 3-15/16" x 7¼" in size, with the exception of mounting provisions and terminals, yet delivers 9½ HP intermittently @ 17,000 rpm. on 56 volts DC. It is designed without an output bearing so that it may be made an integral part of a pump, blower, compressor or other missile component. Type D-1026 will withstand an overspeed condition of no load and 66 volts terminal voltage. It is totally enclosed, explosion proof, and built for excessively high shock and vibration requirements.

EEMCO is able to quickly design, test and develop new motors for special requirements in new aircraft and missiles because it has had years of experience specializing in this field. It makes nothing **but** special motors and actuators for airborne applications. General acceptance of **EEMCO** products by the industry has resulted in the recent completion of another extensive addition to the **EEMCO** plant. These added facilities can work to your advantage.

Specifications

FOR EEMCO MOTOR TYPE D-1026

Output: 9½ HP @ 17,000 rpm intermittent duty

Volts: 56 volts DC

Weight: 12¼ lbs.

Dimensions: 3-15/16" x 3-15/16" x 7¼" (excluding mounting provisions and terminals)

Overspeed: Will withstand 66 volts terminal voltage and no load.

Features: Small size; advanced design; is totally enclosed, explosion proof, built for extreme shock and vibration requirements.

Your Inquiry is Invited

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DESIGNERS AND PRODUCERS OF MOTORS, LINEAR AND ROTARY ACTUATORS . . . EXCLUSIVELY

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the missile week

An m/r staff report from WASHINGTON

• **THE HOUSE COMMITTEE** on Appropriations has cut, by $90 million, the request for military construction funds for ballistic, defense and strategic missile systems. In its report, the committee said the cut was made to $182.5 million because architect-engineer work for certain portions of the *Titan* operational facilities has just been started and won't be completed until early next year. The lawmakers said more money could be requested when plans are firmer and cost factors more realistic.

• **ONE OF THE MORE IMPORTANT** aspects of the proposed Pentagon reorganization is the creation of a Director of Defense Research and Engineering. He should rank just below the secretaries of military departments, and would be authorized to "engage in basic and applied research regarding the development of new and improved weapons systems." He would be the chief adviser to the Secretary of Defense on research activities, and would be empowered to supervise and direct research, including the assignment of such activities to the various military departments.

• **NAVY CIRCLES** in the Pentagon are asking why North American's Scotty Crossfield will pilot the X-15 only on the low-speed and low-level tests. USAF's Captain Iven Kincheloe is scheduled to take the $100 million craft over the real jumps—a definite departure from the normal practice of having the manufacturer complete full-scale tests prior to delivery.

• **INITIAL FLIGHTS OF THE X-15** probably will utilize a dual system of engines used in its predecessors. However, the Reaction Motors power plant should be available within months after first flights. First low level flights are expected early in 1959. Full scale flights probably will not be made until 1960. *Atlas* and several other missiles are being mentioned as the booster to put the X-15 into orbit.

• **AS M/R WENT TO PRESS** the Army was preparing the *Explorer IV* vehicle for launching. Primary reason for the delay has been the lack of proper instrumentation for the satellite. This instrumentation is designed to measure the belt of heavy radiation detected by previous satellites.

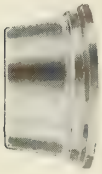
• **A LARGE PART OF THE $50 MILLION** which ARPA has available may go into additional launching facilities at Cape Canaveral and Cooke AFB. ARPA demands the healthy respect from all Pentagonites, but frequently the tune ARPA plays strikes a discordant note to those who must comply. Take *Pied Piper:* one military observer comments, "They took a big chunk of the money we fought so hard to get, they took one of our shops to do the work, and now won't even let our shop people talk to us."

• **LOST IN THE GLARE OF HEADLINES** on the Middle East situation was the Army's second successful recovery of a full-scale *Jupiter* IRBM nose cone. The fact that the *Jupiter* for a second time has been fired successfully, inpacted in designated area, and has been recovered removes any doubt that it is on the threshold of full operational status. Reports in Washington are that during this second firing, the arming and fusing device underwent its first tests in flight, and with success." For this, and other reasons, don't be surprised if *Jupiters* are deployed to overseas IRBM bases before *Thor.*

• **AT WEEK'S END** a major topic in capital missile circles was the outstanding progress of Aerojet-General, as the Air Force announced award of contracts to Aerojet involving the second and third stages of the top AF project—*Minuteman.* Reflecting this expansion was another announcement from the company itself: election of five new vice presidents. Those receiving the nod from Chairman Dan Kimball and his board of directors and their areas of responsibility were: Bernhardt L. Dorman—Test Engineering; Richard D. Geckler—Solid Rocket Plant, Sacramento; William L. Gore—Customer Relations; William L. Rogers—Azusa Operations; John S. Warfel—Avionics.



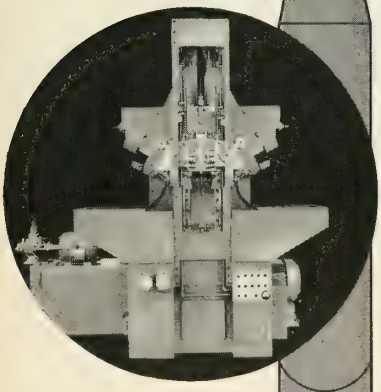
Explorer Nose Cone
Approx. 6″ x 12″



Starter Bearing Mount
Approx. 4″ x 9″



Nike Venturi Nozzle
Approx. 14″ x 33″



New 12 x 15 vertical
Floturn Lathe with
Hydraulic Tracer and
automatic cycling

from nose cones to thrust chambers

IF you are planning the machining or forming of parts for missiles—rockets —jet or rocket engines see LODGE & SHIPLEY—already successfully producing

Noise suppressor cones
Jupiter C nose cones
Nike Hercules nose cones
Outer & inner spikes
for jet engines
Motor mounts—Tail cones
Compressor chambers

FLOTURN LATHE

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FLOTURN SUB-CONTRACT

Lodge & Shipley has a large Floturn sub-contract department for development and production work. This department produces a wide range of aircraft and missile parts for leading manufacturers . . . provides technical assistance and saves costs on any quantity.

MISSILE LATHE

Revolutionary new lathe with swings up to 120″. Designed for the machining of missile and rocket noses, body or venturi sections. Also used to machine welding or assembly fixtures for missile construction.

DUAL TRACER LATHE

All-hydraulic 360° tracer control. Ideal for contour facing, turning and boring jet engine rotor discs, contour turning and boring venturies. Swings up to 43″. Instant change-over to standard engine lathe operation. Extremely useful for premachining blanks to be Floturned.

Let Lodge & Shipley equipment, experience and contract facilities help you. Write for Bulletin FL-102

Lodge & Shipley

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Industry countdown

Money

ARPA has revised its FY 1959 program estimates with new totals as follows (in millions): military space technology $173.6 (up from $138.2); solid propellant research, $20; communications, $9; navigation, $1; cloud cover reconnaissance, $6; component development, $10; launching vehicles, $42; exploratory research, $12.6; maximizing payload capability, $5.7; man in space, $50; satellite tracking, $17.3; total ARPA estimate: $520 million . . . **Navy's asked for $158 million** for aviation facilities construction, including $52.5 million to support fleet ballistic missile program and $18.1 million for Pacific Missile Range at Point Mugu.

Missiles

First full Convair Atlas to be launched from Cape Canaveral was destroyed due to wild gyrations just after take-off . . . **Full Martin Titan** is on test stand at Denver for static firing . . . **North American** X-15 manned rocket space-flight research plane will be equipped initially with engines similar to those in X-1; will get its full power plant later; all are made by Reaction Motors Div. of Thiokol.

Mergers

Houdaille Industries, Inc., Buffalo is purchasing Provincial Engineering Ltd., Niagara Falls, Ont., for cash . . . **National Tool Co.,** Cleveland, has acquired assets and assumed liabilities of Auto-Vac Co., Bridgeport, as part of long-range diversification . . . **A new company,** CFI (Ceramics for Industry) Corp. has been organized in a 15,000-square-foot plant at Mineola, N.Y. . . . **The Cosmodyne Corp.** in Los Angeles has been formed to R&D secondary power sources for missiles, satellites and manned space vehicles; address 2639 So. Laccienega Blvd., L.A. 34.

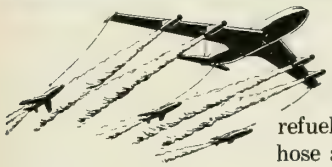
Expansions

NAA subsidiary, Navan Products, Inc., is moving general offices from Santa Monica to 900 N. Sepulveda Blvd., L.A. 45. . . . **Minnesota Mining & Manufacturing Co.** has formed a Missile Industry Liaison staff with offices at 900 Bush Ave., St. Paul . . . **Douglas Aircraft Co.** has formed Nihon Douglas Hikoki K.K. at 9 Roppongi, Azabu, Minato Ward, Tokyo for sales promotion and service . . . **175 Lockheed Missile Systems div. Polaris** engineers have moved into Sunnyvale Naval Industrial Support facility, with more to follow . . . **Bendix Aviation Corp.** has changed name of its controls section to

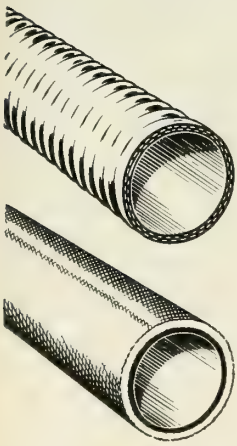

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Solid propellant rocket engines that power many of the latest missiles so vital to America's defense, are mass-produced by Thiokol at the U. S. Army's Longhorn Ordnance Works. Among these are the powerful anti-aircraft Nike Hercules, and the Falcon, and Lacrosse missiles.
Shortly, Longhorn will be mass producing the Army's newest solid propellant ballistic guided missile, the Sergeant.
Engineers, scientists — perhaps there's a place for you in Thiokol's expanding organization. Our new projects present challenging problems and the chance for greater responsibility.
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IN HOSE

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IN-FLIGHT REFUELING HOSE? Vital feature of the probe and drogue method of refueling is the compact, easy-to-handle hose and integral coupling assembly developed and manufactured by Hewitt-Robins. Aerodynamically balanced hose trails at high speed without wobbling, absorbs tremendous shock loads, and provides maximum safety.



VACUUM HOSE? Exceptional flexibility under extreme temperatures combines with long life in H-R reinforced synthetic rubber or silicone vacuum hose. Lengths and diameters for all high-performance applications.

JET STARTER HOSE? For hot or cold air starts using various elastomers. Also specially designed wire braided constructions for recharging self-contained air bottles.

Hewitt-Robins, prominent in development of aircraft refueling hose, makes many rubber products for the aircraft and missile industries. These components are fabricated using all elastomers, including silicones by themselves or with various fabric or metal reinforcements.

Specialists in our Aircraft Products Department can help you put today's new silicone and rubber compounds to best use in aircraft, missiles, and rockets. For information, service, or your copy of comprehensive Product Bulletins, contact your local H-R representative, or Hewitt-Robins, Stamford, Connecticut.

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...industry countdown

Industrial Controls Section . . . **Raytheon Mfg. Corp.** has set up Government Relations branch office at Santa Barbara . . . **Pennsalt Chemicals Corp.** is moving its regional office from Pittsburgh to Natrona, Pa. August 4 . . . **Flexonics, Corp.,** Maywood, Ill., has formed four regional sales offices at Maywood; Inkster, Mich.; Elizabeth, N.J.; Santa Ana, Calif. . . . **International Telephone and Telegraph Corp.** has established an Astrionics lab. at Ft. Wayne, Ind.

Ryan Aeronautical Co., San Diego, has bought 11 more acres at Torrance, Calif., as part of its current expansion . . . **Hoffman Electronics Corp.** Semiconductor div. has acquired 40,000 square-foot neighboring plant in Evanston, Ill. . . . **Packard-Bell Electronics Corp.** has added 20,000 sq. ft. of leased space to its Technical Products div. in West L.A. . . . **Canadair Ltd.,** Montreal, has begun construction of a $1 million environmental lab for missile work . . . **Bruce Industries,** Gardena, Calif. has organized ATOHM Electronics div. . . . **Technitrol Engineering Co.,** Philadelphia electronics firm, has opened an office at 252 N. Irving Blvd., L.A. . . . **Genesys Corp.,** Chance-Vought subsidiary says it's now in business of industrial process control . . . **Owatonna Tool Co.,** Owatonna, Minn., has opened a new warehouse in Chicago.

Technology

Convair Inter-Division Research and Development Center is building a $500,000 gas-driven hypersonic gun to simulate velocities of 13,500 mph . . . **GE Missiles & Ordnance Systems div.** says it is operating country's largest plasma jet for reentry study . . . **Reports are in circulation** of a major break-through possible in manufacture and handling of storable liquid fluorine/hydrogen combinations . . . **National Research Corp.** reports commercial production of very high purity tantalum metal with production capacity at 30,000 pounds a year and expanding.

Finance

Douglas Aircraft Co. reports $593,974,000 sales and $12,645,000 net earnings for six months ending May 31, compared to $565,580,000 and $16,674,000 respectively for comparable period last year . . . **Fairchild Engine and Airplane Corp.** reported to stockholders that company has lost $5 million after taxes for first half of 1958 . . . **Boeing Airplane Co.** has de-

clared regular third quarter dividend of 25¢ a share payable September 10 to stockholders of record August 20 . . . **Boeing** is offering two bond issues totalling $70 million—$40 million at 5% and balance at 4½% . . . **North American Aviation, Inc.,** reports a $18.2 million net income after provisions for $19.7 million for federal taxes and earnings of $2.27 a share for nine months ended June 30, compared to $26.6 million and $3.32 a share for same period last year; sales were $678.9 million and $937.1 million respectively . . . **Douglas** declared a 3% stock dividend payable August 29 to stockholders of record on July 30 . . . **IBM Corp.** reports a net income of $50.6 million for six months ended June 30 compared to $40 million for comparable period in 1957, with earnings of $4.27 and $3.38 a share respectively . . . **Thompson Products, Inc.,** and subsidiaries reports sales of $141.6 million for first six months of 1958 compared to $196 million for same period of 1957 . . . **ACF Industries, Inc.,** reports net sales of $294.9 million for fiscal year ending April 30 compared to $294.6 million last year.

ARPA Briefs

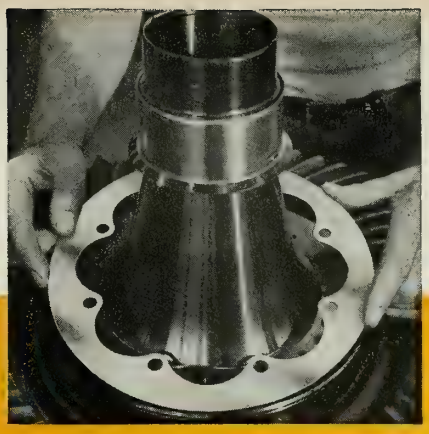
Director Roy W. Johnson of Advanced Research Projects Agency has named William Hutchins, formerly with Raytheon's Missile System Division, to head a Ballistic Missile Defense Group for R&D.

Serving with Hutchins will be Dr. Wade Blocker, kill mechanisms; Clifford Cummings, interception; Stuart Hight, data processing for decisions; Dr. Richard Holbrook, active defense; Harry Iddings, radar; Dr. Ward Low, upper atmosphere physics; Dr. David Luck, very early warning; Dr. Glenn Pippert, range instrumentation and special ranges; Dr. Leroy Tillotson, anti-satellite.

One top AF spokesman said that *Minuteman* could be designed to serve as a multi-purpose weapon. As a single stage vehicle, it would be a tactical weapon with a 200-400 mile range. A two-stage concept would have IRBM capabilities; and with three stages, an ICBM capability.

Already many Washington officials talk about ARPA as becoming the cornerstone for a U.S. Space Force and unofficial thinking is that its current, approximate budget of 500 million dollars will be more than double for next fiscal year. "Beauty of ARPA," one Pentagoner says, "is that it is the stepping-stone to a unified service for space flight—which is just what this country needs. And industry will benefit . . ."

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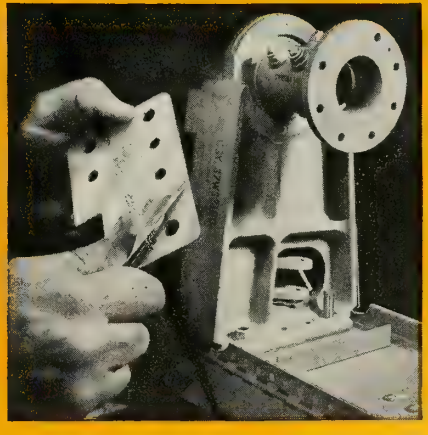


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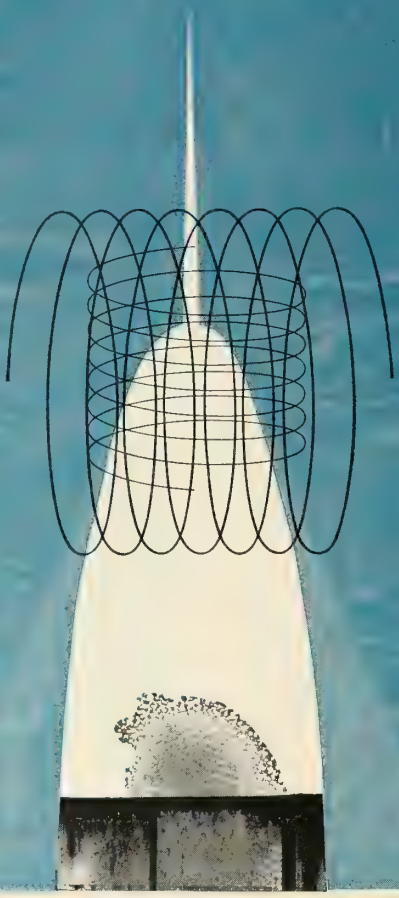


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missiles and rockets
MAGAZINE OF WORLD ASTRONAUTICS

AICBM Defense Cost: $2 Billion Yearly?

Money Will Go to Build New Protective "Fence" Against Missiles; Operational *Nike-Zeus* Seen in Four Years

by Donald E. Perry

COLORADO SPRINGS—North American Air Defense (NORAD) is stepping up its missile defense capability against the manned airplane and the air-breathing missile, but will have to wait four years for an operational anti-intercontinental ballistic missile.

This program, however, will mean billions more dollars annually for aircraft and missile systems extending from the southern border of the U.S. north to Canada, Alaska and U.S. bases in Greenland, under NORAD's 200,000-plus personnel operation.

NORAD leaders are faced with a cold fact: Even though some $18 billion has been spent in the past nine years for modern radar, detection and interception against aircraft, the entire system is not nearly adequate to cope with any missile threat from abroad. But it still must be supported and maintained for another 10 years, until missiles have supplanted the airplane as an enemy's striking force.

In a recent tour of NORAD's nerve system, three members of Congress said they were "shocked" by a statement that NORAD's AICBM capability alone would require $2 billion annually "from now on." This sum is in addition to the $8-10 billion which is now being spent each year—and will continue until 1965—as defense against the manned bomber threat alone.

In an interview with m/r, top NORAD leaders brought out these facts:

- It will take two years before the U.S. Air Force has radars available for the Ballistic Missile Early Warning System (BMEWS), and another two years before operational *Nike-Zeus* are available.
- BMEWS and *Zeus* missile in AICBM program will cost $2 billion annually for "many years to come."
- Canada will soon introduce the U.S. *Bomarc* IM-99 pilotless interceptor for defense of Canada. According to Air Marshal C. Roy Slemon, RCAF, Deputy Commander-in-Chief of NORAD, "Canada critically needs and wants a long-range interceptor missile." He said exact plans on integration of the *Bomarc* in Canada, which now has no surface-to-air missile capability, have not been set by the Canadian government, but *Bomarc* may be produced in Canada under a licensing agreement. Whether U.S. or Canadian troops will man the *Bomarc* sites is undecided.
- Canada is not considering *Nike-Ajax* or *Nike-Hercules* in its system.
- Canadair, through RCA, will hold prime manufacturing responsibility for the U.S.-developed *Sparrow II* air-to-air missile, now being flight tested on Canadian CF-100 interceptor aircraft.

At this time, no plans have been formulated for Canada to have BMEWS radar stations. Most will be located in Alaska. Canada, however, will be "extensively involved" in the BMEWS communications and data assimilation networks with a good many stations programmed for construction on Canadian soil.

Another hard task ahead for NORAD: new selling efforts to the American and Canadian public and a renewal of the 1946 cycle with more emphasis on NORAD's role as a deterrent force with Strategic Air Command.

Why is this necessary? Air Marshal Slemon estimates that 25% of Russia's defense effort is going into air defense, and NORAD's effort "is considerably lower." Russia, he feels, simply started preparing for air defense earlier than Canada or the U.S. "It should be crystal clear why we must catch up and remain ahead," he said.

AF Revises Contract Procedure

By William O. Miller

In an effort to reduce the development-production time of advanced weapon systems, the Air Force is revising obsolete procedures for weapon system completions.

In an interview with m/r, Lt. Gen. C. S. Irvine, Air Force Deputy Chief of Staff, Materiel, said under the new policy, qualified contractors will be screened on their capability, past experience, design approach, and management techniques.

This means that one, two, or more contractors will be given a contract to proceed with Phase I design, which will include such projects as wind tunnel work and mock-ups. The Air Force will evaluate these contract efforts until one contractor can be selected.

These techniques were used in choosing North American Aviation, Inc. the contractor on the B-70 and F-108.

General Irvine pointed out that as the complexity of modern weapon systems continues to increase, it becomes more incumbent on the Air Force to assure that the maximum effort and results are obtained for each dollar spent. This has created trends in the practices and policies of contracting where a maximum amount of incentive for efficiency is created.



Lt. Gen. C. S. Irvine

- **Need better data**—"Time was," Gen. Irvine said, "when, if we had a decent estimate of the weight of a system, our knowledge of cost per pound would allow us to come up with good cost data. With the fantastic jumps in

performance and its direct companion complexity that are now being made from one system to the next, historical data becomes less and less useful.

"Some of the complicating factors are the problems of new and untried materials and processes, tolerances that the 'state-of-the-art' could not visualize too long ago, and the need for unmanned vehicles to be in a state of readiness for years before they may need to be fired.

"In weapon system contracting, we usually start out during the study, and strictly development stage, with a contract that allows for a fixed fee. As early as possible, however, we switch over to an incentive contract to create maximum initiative and get the most for our money—the goal that I described previously.

"This is not a firm formula and each case, of course, merits and gets special consideration. For example, on the KC-135 we were able to start out initially with an incentive contract and a good firm target price. This was possible because of cost data available from an earlier company effort on a similar commercial version of the airplane and from information available from design competitions.

"The incentive approach," Gen. Irvine continued, "is nothing more than dealing with our contractors on the basis that, if they do a better job, they earn more profit. The degree of split between the Air Force and the contractor on money saved varies in the incentive formula. The application of the proper formula is determined by many things; one of the most important is risk."

• **Picking contractors**—Contractor selection is much more difficult than it formerly was, according to Gen. Irvine. The policy used to be to canvass the entire industry and request detail proposals to meet the stated requirements. The Air Force would review and evaluate these proposals and award a contract to one company for detailed design and fabrication of flight test systems.

"The disadvantages of such a method are obvious," Gen. Irvine said. "The Air Force (depending on the number of contractors involved) could spend as much as a year doing the evaluation. Time is a luxury we cannot afford.

"The Air Force is doing everything possible to promote fair and honest competition, while at the same time we are making every effort to reduce the development-production time cycle. We are also using all the tools at our command to establish a maximum initiative and incentive in our contracting procedures. These efforts have paid and will continue to pay dividends."

Minuteman-AF Contract Switch

by Norman L. Baker

An example of the Air Force's swift change in business procedures (p. 49) is its approach to the weapon system concept in the *Minuteman* program.

For the first time, there will not be an industry prime contractor. Instead, m/r has learned, the prime manager will be the Ballistic Missile Division with Ramo-Wooldridge acting as technical assistance manager.

Five contractors were selected for research and development efforts on the three-stage ICBM. This was the culmination of about a year of investigation of the problems involved capabilities of several companies.

The contractor selection will be followed by contract awards as soon as the Department of Defense releases the funds to the Air Force and the paper work completed. The amount of the contracts was not announced pending the formal contract releases.

At least five companies were in the running for the development of the large solid propellant grains required for the land-based missile. Thiokol Chemical Corp. received the contract for the first stage, with limited backup by Aero-General. The first stage grain is reported to be 6 feet, 5 inches in diameter. Development and production of the propellant for this stage is expected to be at the Thiokol-Utah division.

Aerojet-General will develop second and third stages, with a backup program by Thiokol. A radically different motor case will be used in the Thiokol second stage. In addition to the Thiokol backup on the third stage, there will be a limited research program by Hercules Powder Co. (ABL) for investigation of the double-based propellants. Second and third stages are reported to be 44 and 37 inches, respectively.

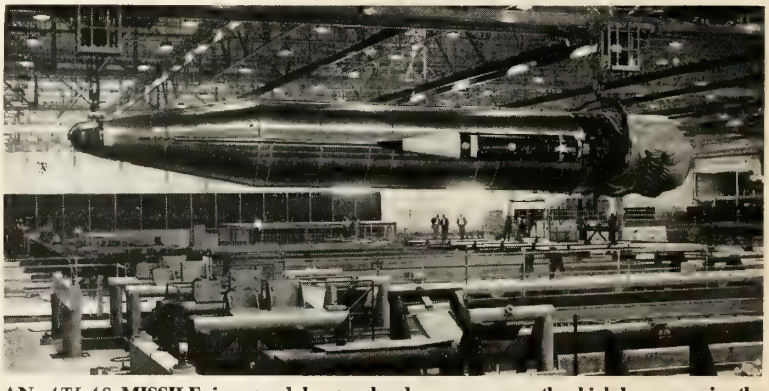
Astrodyne and Grand Central Rocket Co. were top contenders for the upper stages. These companies are expected to be called in on a follow-on program.

The Autonetics Division of North American Aviation will develop the guidance system, expected to be pure inertial. Autonetics was recently selected as a subcontractor on the *Dyna-Soar* boost glide bomber team headed by Boeing. Avco Manufacturing Co. has been assigned the development of the nose cone for the solid propellant bird. Avco is curently engaged in the development of nose cones for the *Titan* ICBM and the Navy's *Polaris* Fleet Ballistic Missile.

Jupiter Nose Recovery Affirms IRBM Status

The recovery by the Army of a second full-scale *Jupiter* IRBM nose cone on July 17 removes any doubt that the missile is on the threshold of full operational status.

The successful recovery of the nose cone affirms that the *Jupiter* team has solved the warhead protection problem. The cone recovery gear, developed by Cook Electric Company, Evanston, Ill., consisted of a large colored balloon, signal lights, radio transmitter, and other instruments which aided in the location of the cone.



AN *ATLAS* MISSILE is moved by overhead crane across the high-bay area in the new assembly plant by Convair Astronautics. Manufacture of the *Atlas* is now underway at the plant. The Air Force made five attempts to fire the first full-powered *Atlas* last week without success. The missile, destroyed after 45 seconds because of erratic flight, was equipped with three engines developing a total thrust of 360,000 pounds (boosters—300,000 at 150,000; sustainer—60,000).

Thiokol Disclaims Plan to be Prime Contractor

Thiokol Chemical Co. has no plans to become a prime systems contractor, according to Dr. H. W. Ritchey, Vice President.

Dr. Ritchey stated that "The history of engine development and production activities in this country had demonstrated the validity of separating such activities from airframe development and production.

"We believe," he continued, "that the current tendency to combine a wide range of technologies into a single organization can only serve to weaken the technological strength of many of the groups engaged in sub-system development. The current tendency to integrate rocket development technology with prime systems capability could have a very debilitating effect upon the whole industry."

In its own field of rocket engines, Thiokol has enjoyed a constantly expanding role. Besides the recently-announced first-stage engine for *Minuteman*, Thiokol also produces engines for *Sergeant, Falcon, Lacrosse;* the booster for *Matador-Mace;* and has participated in the *Hawk* and *Polaris* programs.

During the past year, Thiokol made the following aquisitions aimed at complete rocket engine capability: Reaction Motors, liquid rocket motor specialists; Hunter-Bristol, metals firm; and National Electronics.

House Forms Permanent 25-Man Space Committee

A permanent committee on science and astronautics to handle all space legislation has been established by the House.

The committee will consist of 15 members and will have jurisdiction over all legislation relating to basic scientific research, science scholarships, the Bureau of Standards and the National Science Foundation.

House Democratic leader John W. McCormack called the committee one of the most important in Congress. The committee was established by voice vote of the House, under sponsorship of Democratic Whip Carl Albert.

A Select House Space Committee, which previously handled space legislation, will pass out of existence at the end of the present session of Congress.

British IRBM Bases Set; France Delays *Jupiters*

While plans are moving ahead for the activation of the first of the four *Thor* missile bases in Britain—probably before December—the hoped-for deployment of *Jupiter's* to France is temporarily on the shelf. The French government of Gen. De Gaulle insists on attending to what it considers more pressing problems.

The original target date for sending the IRBM's to France had been set for March of next year. The delay will force a postponement. Three bases have been mentioned as the initial number for France.

Present production of *Thor* is considered ample for current commitments and test requirements. Douglas engineers and test personnel are presently carrying out the final phases of delivery of *Thor's* at the bases. The British will man only partially the bases in the beginning, but eventually will provide all personnel. Meanwhile, Britain is furnishing sites, local construction and other housekeeping requirements. The warheads will remain in the custody of the U.S.

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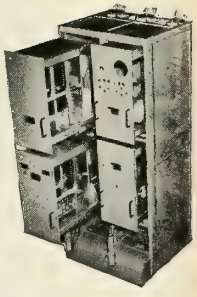
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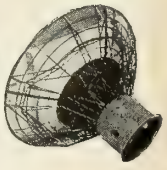
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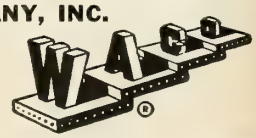


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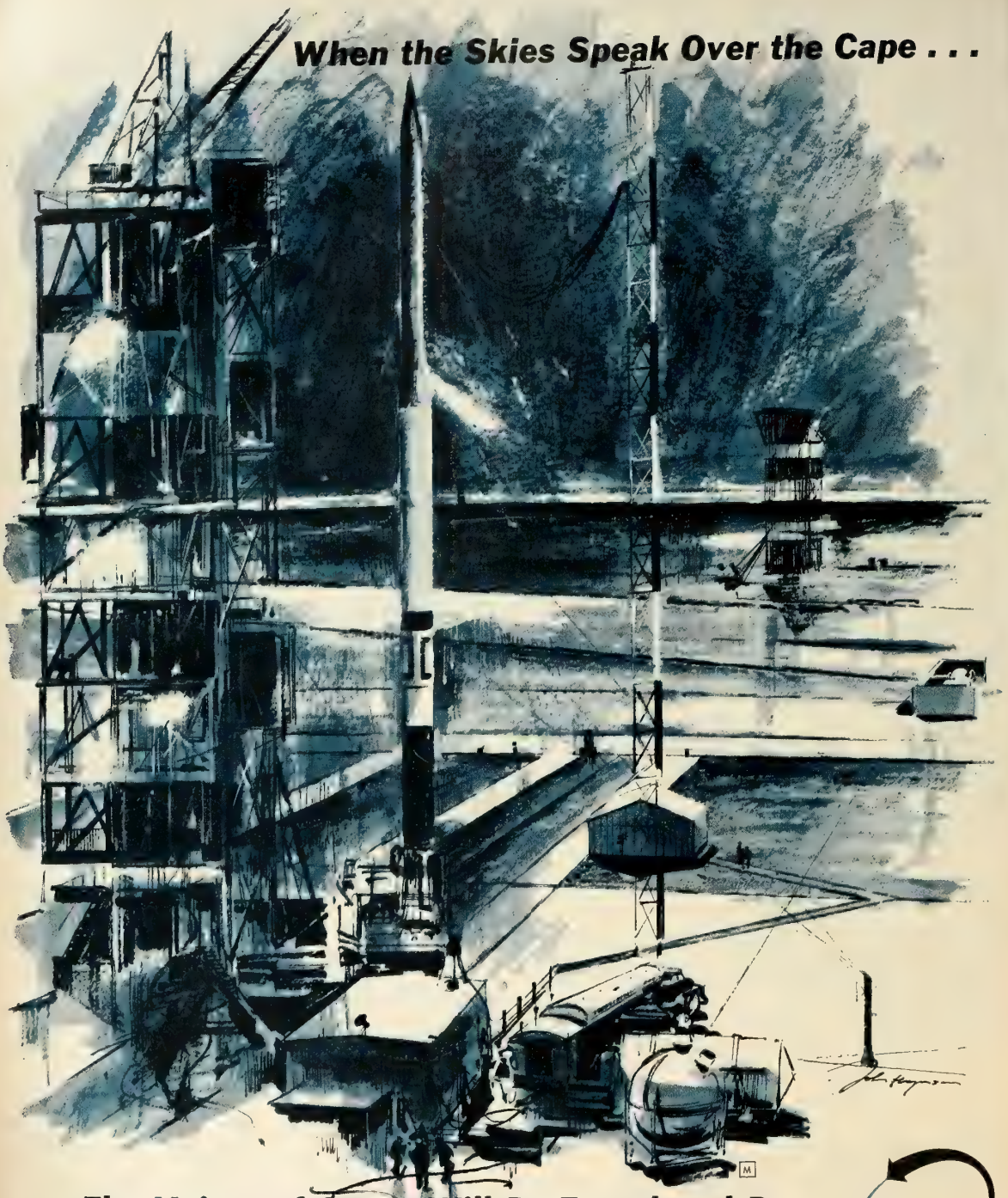
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Progress Report:

AFBMD: Catching Up With the Soviets

by Maj. Gen. Bernard A. Schriever, USAF*

NEXT MONTH, THE AIR FORCE Ballistic Missile Division will mark its fourth anniversary. These past four years have been busy, eventful ones.

AFBMD's initial task was to develop a ballistic missile capable of carrying a thermonuclear warhead to intercontinental ranges—namely, the *Atlas*. Today we are in the advanced development phase of three liquid propellant ballistic weapon systems—the *Atlas* and *Titan* ICBMs, and the *Thor* IRBM.

We have recently entered the initial research and development phase of the *Minuteman*, an ICBM using solid propellants with advanced components and configuration.

In addition, AFBMD manages the research and development aspects of a proposed satellite for observation purposes and scientific study. More recently, AFBMD was assigned the task of developing and operating an unmanned outer space vehicle capable of making a close approach to the moon for the purpose of basic scientific research. The latter two projects are under the direction of the Advanced Research Projects Agency of the Department of Defense.

• **Quick and complete** — When AFBMD was assigned its task four years ago, it was faced with the necessity of cutting the time normally required to build and operate in the field a weapon system of comparable size, complexity and novelty. It was realized at the outset that an entirely new approach to the problems of weapon system development-management was called for.

Therefore, the decision was made four years ago to undertake all phases of the design-to-production-to-operation cycle concurrently, rather than sequentially. This approach involved carefully-calculated and balanced ingredients of talent and resources. Today that combination is paying off handsomely at Cape Canaveral, where *Thor* and *Atlas* are progressing beyond expectations in the flight test phase. *Titan* is expected to follow sometime this year.

The concurrent approach to weapon system development required designing the operational bases and the



ground support equipment systems before the operational missile designs were off the drawing boards. Training plans and logistic support plans were drafted along with the test plans.

Construction of Cooke AFB, the combination training and operational launching base, was started before the first ICBM test missile was launched. Other purely operational bases will be ready for use before the completion of the test program.

A complete prototype of the *Thor* launch emplacement was assembled, checked out and operated by crews of the Strategic Air Command several months ago. Equipment of this type is already being shipped to operational destinations ahead of original deadlines, which were considered optimistic several years ago.

It is this concept of concurrent action that will make it possible to attain an operational capability for *Thor* before the end of this year—only three years after the signing of contracts.

• **For the future**—By dealing boldly and realistically with the needs of the present, we have, at the same time, equipped ourselves to contribute to the needs of the future. In the process of developing the first generation ballistic missiles, we have made a capital investment in space technology of over $500-million worth of new facilities, which form the previously nonexistent building blocks for the development, testing and production of ballistic missiles and space vehicles.

We have also gained invaluable experience in the planning and management of multi-billion dollar projects of unprecedented complexity and compression. The three original ballistic missile programs alone involve 18 major contractors, more than 200 principal subcontractors, and over 200,000 suppliers and vendors.

The most noteworthy—and certainly the most noticeable—aspect of the ballistic missile program during the past year has been the flight testing at Cape Canaveral. For those of us who are directly engaged in the ballistic missile program, the tests are the first gratifying returns from calculated risks that had been assumed years earlier.

From here on, we see the development of *Thor* and *Atlas* as straightforward engineering tasks, with no unsolved scientific mysteries or dead-end testing. How can we have such confidence before the successful completion of an extensive flight test program? The answer lies in the fact that flight testing is the culmination, rather than the commencement, of the test phase of an Air Force ballistic missile.

For a point of reference, consider that the Germans in World War II flight tested some 2000 V-2's before they considered that the weapon was ready for operational use. It is obvious that with complex and expensive missiles such as the *Atlas, Titan* and *Thor,* we cannot afford the time, money or other resources to conduct such a numerically large flight test program.

It is not necessary to conduct such a program, even though a single flight yields only a few minutes or even seconds of precious data. This data accurately and faithfully records the pulse of the missile throughout its life span. The problem we face—to minimize the number of flight tests and maximize the effectiveness and usefulness of the flights that are made.

• **Program**—AFBMD's test program is, therefore, based on these

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fundamental principles:

1) "Dead-end" testing is avoided wherever possible.
2) All testing is done at the lowest possible level.
3) Flight test results are utilized to the maximum.

The decision to avoid "dead-end" testing wherever possible means that instead of developing special test vehicles, the missiles themselves serve as data-collectors. The missiles being flown today are made up of the same components and subsystems that will be used in the operational missiles.

These components are fabricated on production lines, using production drawings and tooling. By this means, we are constantly broadening our statistical experience on the operational hardware and improving our manufacturing methods and procedures.

To aid in understanding the principle of testing at the lowest possible level, we can represent the overall test program as a pyramid. The broad base of the pyramid is the component testing, in which each part, component, and subassembly is individually tested in excess of anticipated flight conditions.

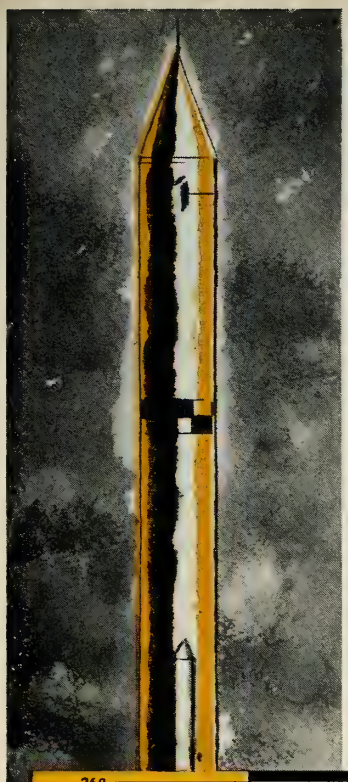
Having proven the design, we next assemble the components into subsystems and again test exhaustively, but now with the added factor of component interactions. Moving higher up the pyramid, we reach complete system testing, but under "captive" conditions on the ground. Here we are able to assess the interactions of the several subsystems during a "hot" firing sequence.

Of course, some of the environmental conditions of flight can never be fully simulated on the ground, and we must finally commit missiles to free flight—but not before all probable causes of malfunction have been sought out and removed at the lower levels of testing. By this program of careful and progressive testing, we gain maximum assurance that the free missiles will perform as planned.

It should be recognized that a highly sophisticated long range ballistic missile such as *Thor, Atlas* or *Titan* cannot be expected to function perfectly each time it is flight tested, particularly in the early stages of a program. If we knew in advance that every subsystem would function perfectly in flight, it is obvious that we wouldn't need a flight test program.

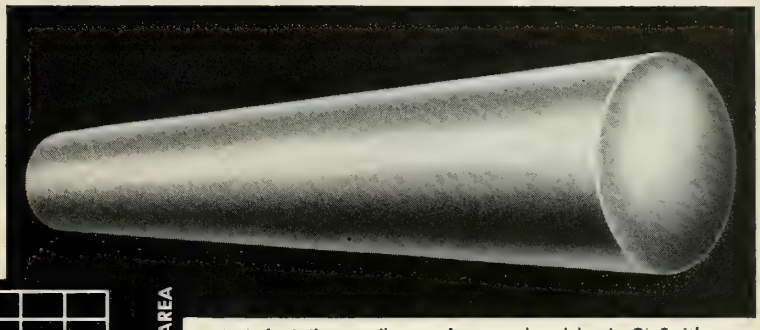
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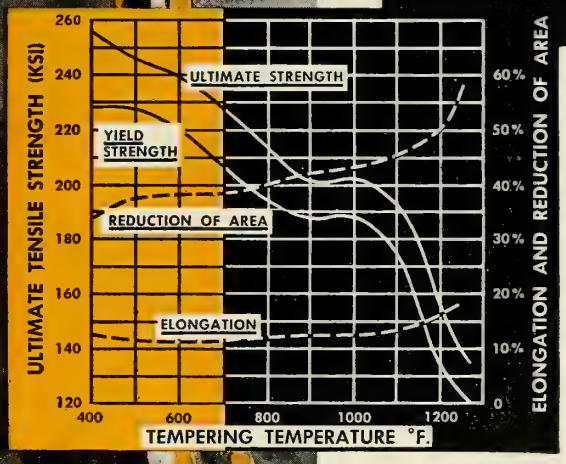


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less than the planned duration will furnish precious data on vibration, fuel sloshing, engine ignition and burning, critical temperatures, and component interactions.

• **Objectives**—When we finally reach the flight test phase, our objective is to obtain the greatest possible amount of the most usable kind of data. Each flight is assigned specific test objectives, which vary in progressive steps from missile to missile.

Initially, our interest centers on the brief period of powered flight. Later, missile behavior throughout the entire trajectory of a full distance flight is scrutinized. A typical test might yield over 100 different telemeter measurements, along with the highspeed photographs obtained during the visual portion of the flight.

The test objectives of a given flight frequently include the acquisition of data needed for more than one of our three ballistic missiles. For example, *Thor* flights have carried, as part of their instrumentation, equipment that will be used in the *Titan* guidance system. This advantage derives from AFBMD's centralized management of the entire Air Force ballistic missile program.

The test data obtained from all flights, whether wholly or partially successful, is processed at data reduction centers and analyzed in meticulous detail. When a failure has occurred, its causes are sought and theoretical solutions proposed. The resultant "fixes" are then verified in a new pyramid of ground tests before committed to flight test. Test data obtained is also made available to both the Army and Navy for their use.

Before considering AFBMD's newer projects, a word is in order regarding the decision-making process by which advanced projects are conceived.

It is well to note here that a scientific breakthrough in a single area of technology does not in itself constitute the basis for a new generation of weapons. All of the major subsystems must be brought along together to a new level of sophistication that will justify the commitment of time and resoures to the new project.

Thus *Minuteman*, for example, will not only be the beneficiary of a major breakthrough in solid propellant technology, but will also incorporate projected advances in airframe, guidance, and warhead technologies. In addition, developments in related scientific aspects such as geodesy and gravimetry, are being projected ahead to the target date for the operational *Minuteman* and made part of the design criteria.

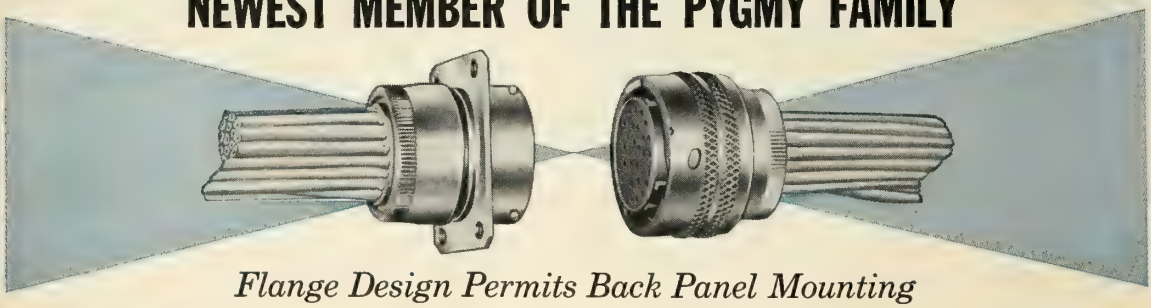
Similarly, more rigorous strategic requirements, such as those related to the ability to withstand attack, are "cranked in" to the new weapon system design and operational environment. Operational requirements such as reaction time, reliability and vulnerability are made more stringent.

• **Long range logistics**—These subsystems and environment improvements are projected on a time scale so that they will intersect at the target date, several years distant, for the operational use of the new weapon system.

This type of planning is necessary to assure that major subsystems will be mutually compatible, and that the new weapon system will incorporate the most advanced technology that can be anticipated. Of course, plenty of latitude is allowed for unforseeable refinements that will be made in the state of art as the research, development, operational effort and experience progresses.

For example, *Thor* subsystems are

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continually being improved to yield substantial performance increases that will enable us to exceed original design specifications. These changes are being introduced into the *Thor* in an orderly, programmed way.

The growth of scientific knowledge and practical experience are continuous processes, and at best fit uncomfortably into the tidy packages called development cycles. Problems of propulsion, guidance, reentry and space medicine are no respectors of names like *Thor, Atlas* or *Titan*. These problems simply exist, tantalizing and frustrating the planners and the engineers. They must be solved by whatever means and resources can be brought to bear on them.

AFBMD's various projects in ballistic missile development and space research are likewise closely interrelated. Borrowers all, these projects will continue to share technology, hardware and facilities as the Air Force extends its space age capabilities toward the goal of piloted space flight.★

Ramo-Wooldridge Veeps Given New Roles

Four Ramo-Wooldridge Corp. vice presidents have had a shift in responsibilities.

Dr. Ralph P. Johnson, formerly vice president, research and development, now heads the General Electronics Group of the divisions. His duties include direction of all research, engineering, manufacturing and administrative activities of the company except those of Space Technology Laboratories and the Thompson-Ramo-Wooldridge Products Co., both of which will report to the president.

Former vice president and director of the Communications Division, Dr. Burton F. Miller, becomes vice president and director of advanced systems planning and, with Drs. Wooldridge and Ramo, will plan and arrange the corporation's entry into new product areas.

Milton E. Mohr has been named vice president-engineering, and will be responsible for the Control Systems Division, Communications Division and the Electronics Instrumentation Co. He was formerly vice president and director of the Control Systems Division.

Irwin A. Binder, vice president, manufacturing, will have direct responsibility both in Denver and Los Angeles of the Manufacturing Division.

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Progress Report:

Big Challenge: Missilizing Our Navy

by RAdm. K. S. Masterson, U.S.N.*

IN THE PAST FEW YEARS IT HAS BECOME more and more obvious that guided missiles are dominating the scene to a greater degree with each passing day. This is true throughout the Department of Defense, the Joint Chiefs of Staff and all the Services.

It was during World War II that the requirement for guided missiles in the Navy was born—primarily as a result of the highly successful Japanese Kamikaze attacks. The immediate requirement was for a fleet defense surface-to-air guided missile, and this led to the Navy's highly successful—and then highly secret—*Bumblebee* program, from which evolved today's naval surface-to-air *Terrier, Talos,* and *Tartar* missiles.

In view of its versatility, the Navy has a requirement for all categories of guided missiles. (Surface-to-air, air-to-air, air-to-surface, and surface-to-surface). This is because the Navy goes where the fighting is—taking her missiles, launching platforms, and airfields for both offensive and defensive operations. In addition to the requirement for all categories, the Navy must have missiles of different sizes within a category because of the difference in size and mission of ships and aircraft.

Naval weapons systems must function in the very special *environment* of ships at sea. This means that our missiles must inevitably be more complicated and specially designed; and therefore, sometimes become more expensive than similar missiles.

• **Problems of ships at sea**—The Navy is especially proud of its achievements in guided missiles—not only because of the technological advances made, but because these achievements were made in the face of very special problems—problems created by the environment of ships at sea. The Navy has the problem of limited space aboard ship.

Missiles must be comparatively small for stowage in ships' magazines, and must live in close proximity to their launchers. This is not true of land-based missiles. Navy missiles must be safe in storage, because we live with them aboard ships at sea. We can't set up launchers in great numbers, and those we have must be capable of rapid reloading with a minimum of readiness time.



Our missiles must be capable of stowage in sufficient numbers in confined magazines to provide an effective combat capability. This imposes severe electronic and engineering problems upon our areodynamic engineers, who must get the absolute maximum out of small and folding wings and the aerodynamic body of the missile. We have the special problem of a launching platform in constant motion in all axes, and stowage under conditions of severe vibration.

We have the problems of highly corrosive salt spray, and of operating in a hot climate one week and a very cold one the next. And since we can carry the missiles only in limited quantities, we must have an extremely high order of reliability. Finally, in the case of our aircraft missiles, we have the very special problem of repeated catapult take-offs and arrested landings, imposing a unique requirement for ruggedness of circuitry and missile structure.

Even in funding, the Navy has a somewhat unique problem. In this connection, it is important to realize that the Navy, within the total budget, has to support a combat capability on land, on the sea, *under* the sea, and in the air. No other service has such a broad demand on its overall budget. On top of this, *nuclear* as well as *conventional* capability must be provided.

Despite these problems, we still have a good missile program, and we *do* have a significant missile capability at sea today—and it will improve steadily as time goes by. This program supports current and future operational requirements of our operating forces at sea.

• **Air defense requirements**—Two categories of missiles are being developed, namely: surface-to-air and air-to-air.

In the surface-to-air category, the Navy has three projects—*Terrier, Talos* and *Tartar*. These are related in their basic operational techniques, but markedly different in size and performance characteristics.

Terrier is launched with a solid rocket booster. After launch, the booster separates and the missile's solid-rocket sustainer is then ignited and maintains the missile at speed. *Terrier* is a beam rider; the same radar which tracks the target also supplies the beam which guides the missile to the target.

Terrier is in the fleet on the cruisers Boston and Canberra and the destroyer Gyatt. In addition, two aircraft carriers, three cruisers and seven frigates, either being converted or constructed, will carry *Terrier*. Shipboard *Terriers* are selected from the magazine, loaded, trained, elevated, and fired automatically.

The next of the surface-to-air missiles is the *Talos*. *Talso* is a long range missile, and provides tremendous killing power in its role of fleet air defense. It is going to exert a big impact on fleet operations.

The first ship to have this capability is the cruiser Galveston. Additional cruiser conversions are planned. The first nuclear cruiser, Long Beach, will be *Talos*-equipped. The third missile in this category is the newest and smallest-*Tartar*. *Tartar* is designed for use from ships as small as destroyers, and for secondary battery use from cruisers.

Air-to-air missiles are becoming the primary fighter aircraft armament,

*Director, Guided Missile Division, Offices of Chief of Naval Operations.



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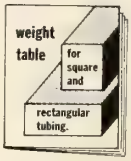
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. . . Navy challenge

contributing vitally to effective fleet air defense. As the inner defense is taken over by surface-to-air missiles, missile-armed fighters will push the defense perimeters farther and farther outward —making it increasingly difficult for enemy bombers to penetrate to weapon-release points.

A most successful operational air-to-air misile is *Sidewinder*. It is effective to altitudes over 50,000 feet. Squadrons are deployed with this weapon in the Mediterranean and in the western Pacific.

Another air-to-air missile in the fleet is the *Sparrow* I, a supersonic beam rider. Navy is pursuing an orderly course of design improvement in this air-to-air field, and the next member in the fleet will be *Sparrow* III.

• **Attack requirements**—The projects mentioned so far relate to air defense. The following are plans directed toward the attack requirement.

The *Petrel*, an air-to-surface missile, is launched from aircraft, flies to a point near the target, and then drops a torpedo which attacks the surface target. Recently production was completed, and the missile and its aircraft were transfered to the reserve fleet.

Bullpup, another air-to-surface guided missile, is a highly accurate weapon system which will materially increase the effectiveness of light attack aircraft in tactical missions. It is scheduled to become operational this year.

This brings us to the surface-to-surface category. Here the Navy can make a particularly significant contribution to our total offensive military readiness.

The surface-to-surface missile lends itself to either surface-to-surface ships or submarine employment. With essentially no supporting forces, individual guided missile submarines, nuclear-powered, can operate in the face of strong defenses and in widely dispersed areas for indefinite periods of time.

To be operationally and economically acceptable, surface-to-surface missiles of intermediate or long range must carry nuclear warheads; therefore, they can be either deterrent weapons or weapons for specific tactical uses. The Navy has been developing surface-to-surface missiles of two types —air breathing and ballistic. Navy air breathing missiles consist of *Regulus* I and *Regulus* II.

Regulus I is currently available for deployment and use from submarines, cruisers and carriers. There have been many successful flights of *Regulus I*.

Regulus II has been developed as

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. . . Navy challenge

a direct product of the *Regulus* I program. *Regulus* II is now being flown in flight tests at Edwards Air Force Base. It flies faster, and for greater distances, than *Regulus* I. Like *Regulus* I, it will be lanuched from submarines and cruisers.

• **Ballistic missiles**—*Polaris,* the Navy's Fleet Ballistic Missile, will be a sea-based, intermediate range missile for use against land targets. Current development is aimed at achieving a solid propellant rocket capable of ranges up to 1,500 miles.

Polaris is a system of which the Navy can speak with great pride. When it goes to sea, it will have the qualities of a practically invulnerable missile system.

It will be mobile and capable of concealment. It will be fired from beneath the sea—its firing position invisible, and unknown to the enemy. It will involve no real estate question. It will not be provocative—it will simply be ready.

The Navy's missile launching sites are moved to where they are needed. This simply means that the Navy provides the nation with a *minimum of launching sites to cover a maximum of target areas.* Seventy per cent of the world's surface is water. Thus, with ships, submarines, and carrier aircraft, the Navy provides a mobile missile platform which this country can count on almost anywhere in the world to promote and maintain peace, or to fight any type of war that may eventuate.

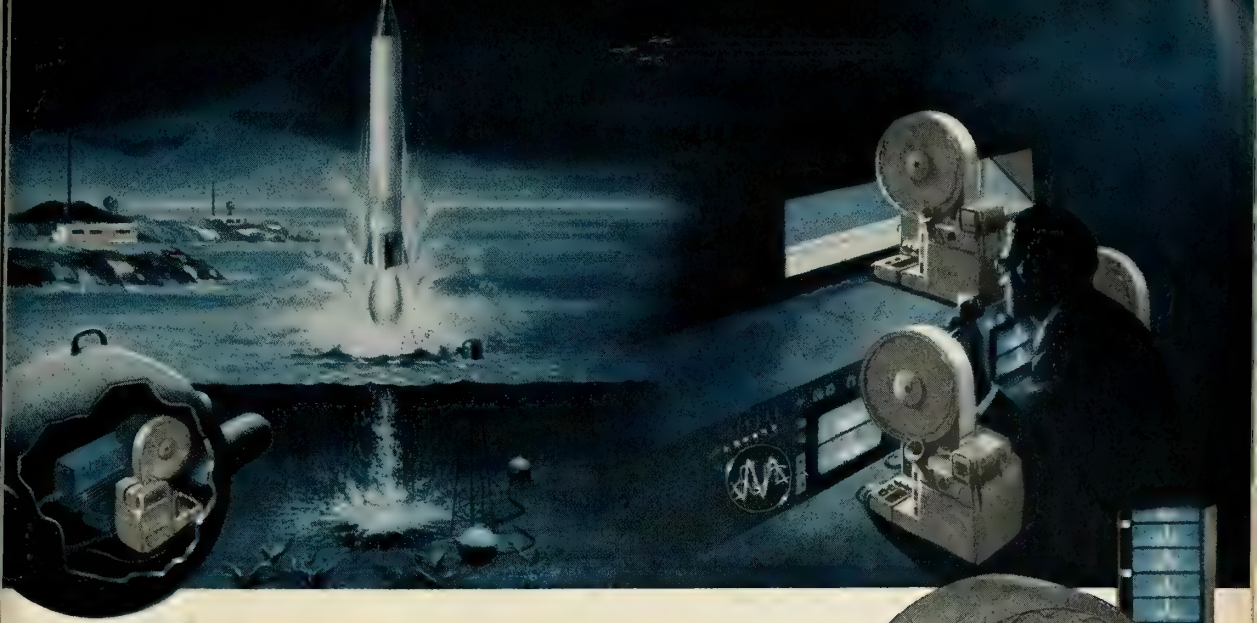
The Navy's guided missile program is designed to provide a continuing combat readiness in the fleet at sea now; and, at the same time, to provide for the weapons of the future as the state-of-the-art progresses and the enemy threat increases.

Guided missiles are just infants, but they're evolving fast! They've been called rockets with a brain. Let's hope they never learn to think! But, then, perhaps, thinking missiles would all join forces to combat the monsters we humans have created.

We in the Navy are proud of our missile program. We are adapting missiles where they can do the most good in modernizing our fleet—ships and aircraft—for control of the seas, the Navy's main mission.

The Navy has many different jobs to do, but it is only one member of the defense team. The Army, the Air Force, and the Marines are all part of the team and each service has to do its job if the U.S. is to maintain its strength.

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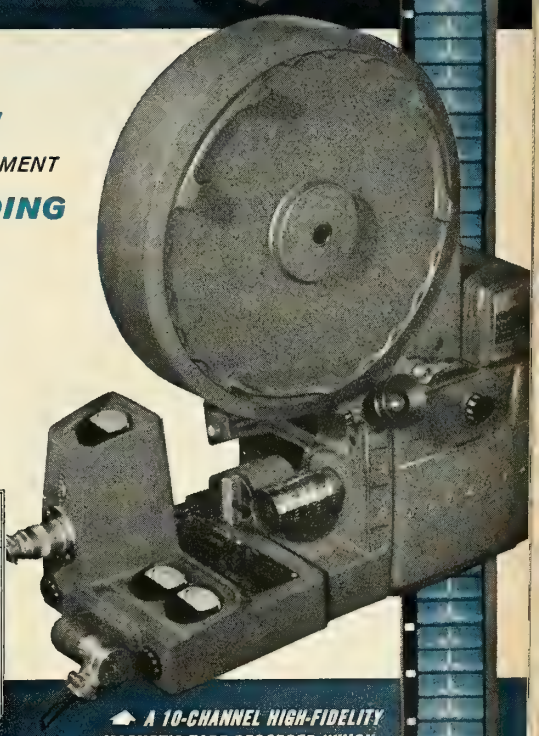
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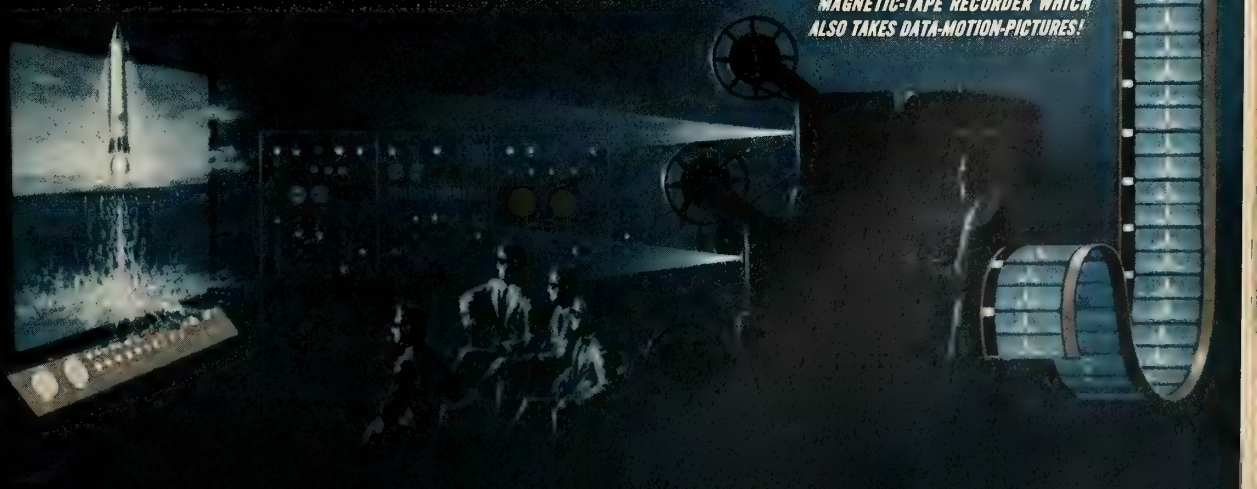
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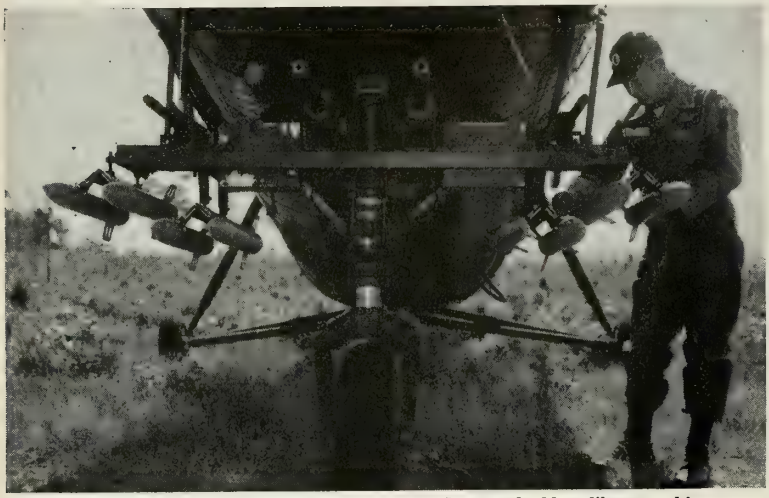
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Progress Report:

Army Pushing "Brush-Fire" Missiles

by Raymond M. Nolan



VERTOL H-21C mounting 80 mm Oerlikon rockets and .30 caliber machine guns. Tests were conducted at the Army Aviation School, Fort Rucker, Alabama.



PRESENTLY UNDERGOING TESTING is the Sikorsky H-34A. Armament includes forty 2.75 inch rockets, two 5-inch rockets, two 20-mm cannon, and six machine guns.



IN A DEMONSTRATION AT WHITE SANDS, this Sikorsky H-37 is teamed up with two other H-37's, to transport an *Honest John* with launcher and jeep-trailer.

PROGRESS DURING THE PAST YEAR for the Army can quite rightly take other forms and names, such as consolidation and planning. Although a number of new missiles were shown, they had in fact emerged as weapons before the year began.

The Army obviously had ample capability to do more. Certainly, the excellent development teams at the Army Ballistic Missile Agency, Jet Propulsion Laboratory, and Redstone arsenal have proved that they are capable of taking any assignment and turning it into hardware.

However, approvals of new projects in the past year have been few. One of these was an invitation to participate in the lunar probe program.

In the field of tactical weapons, claims are made that excellent progress has been made, but in most cases there are qualifying circumstances to the release of information on new missiles. For example, the *Sergeant* was unveiled during 1958, although press announcements reportedly had been prepared for almost a year.

In the space field, the *Jupiter-C* made its mark, but it wasn't too different from the Project Orbiter concept that was proposed in 1955. The actual *Jupiter* missile has had a slowdown in testing—due in part to gearbox troubles —but also due to a shift in emphasis to *Jupiter-C* and to the re-entry problem.

Since funding of the *Jupiter* is now an Air Force problem, no mention is made of it in the Army budget. The largest single missile item, instead, is $109 million for the *Redstone*, the first true U.S. operational ballistic missile.

In the anti-missile area, the *Nike-Hercules* seems about to replace the *Nike-Ajax* as first line of anti-aircraft defense, and the *Nike-Zeus* won the choice for the anti-missile missile over the Air Force *Wizard*. However, funds for *Nike-Zeus* production have been severely limited (m/r July 21, p. 32)

In the field of planning, the *Pershing* is probably the most exciting prospect, but it is still to early in development to count as a weapon. Observers are watching this first attempt by ABMA to relinquish systems responsibility to a prime contractor.

Project *Mauler* is another missile still in the planning stage. Reported to be a successor for the 40 mm anti-aircraft shell, it also will be used in area defense after attack by larger missiles.

A contract has been let for a follow-on to the *Little John;* and another version, called the *Chopper John* because it is helicopter-borne, is in the works.

• **Engineering**—Under the heading of engineering progress, probably the most significant development within the past year has been the emergence of the helicopter as a missile platform. At the recent AMMO (Army Mobile Missile Orientation) staged at White Sands, (m/r July 7) the helicopters stole the show.

The use of helicopters to carry missiles had its beginning in 1956. The Commanding General, Continental Army Command, authorized the Army Aviation School at Fort Rucker, Alabama, to conduct a series of experiments to determine the feasibility of adapting different weapons, including missiles, to helicopters both of the present type and more advanced types expected in the future.

The feasibility studies, as far as missiles were concerned, were an unqualified success, and for the past year, the Army has been asking for, and getting, a number of proposals from industry. So far, no word has been released about contracts in being, but undoubtedly there are a number of studies going on at the present time.

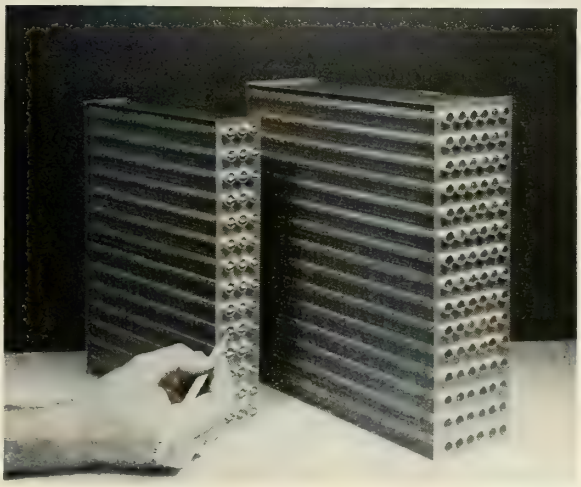
The helicopters at White Sands carried an impressive array of missiles, ranging from 80 mm Oerlikon rockets to 5-inch anti-tank, anti-submarine rockets. Because of the extreme maneuverability of the 'copter, the usable range and deployment of the missiles was greatly increased. It seems only a matter of time until larger missiles are mounted and used.

The French have already demonstrated the feasibility of larger rockets by mounting SS11 rockets on their *Alouette* helicopter. Since our *Dart* missile is very similar to the SS11, it should only be a matter of time before helicopters are carrying them as tactical weapons.

As a missile carrier in close-in tactical operations, the helicopter has no equal. The Sikorsky H-37 has demonstrated that it can carry the *Honest John* with no trouble in a sling arrangement.

With the global situation being what it is, and "brush-fire" wars the most likely kind to occur, helicopters firing rockets might very well be the only type of missile warfare we will engage in for some time to come. In any event, the fact that we have extended the range and deployment opportunities of small missiles means that a new type of weapon system is in existance—a firing platform for small and medium tactical missiles.

INNER-FIN reduces size of electronic cooling coils 60%



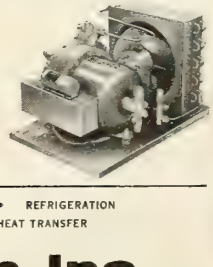
Size Comparison, Inner-Fin Coil and Standard Coil

INNER-FIN coils have proven the answer to the ever-present space problem in aircraft and electronic cooling equipment. Dunham-Bush engineers effected a 60% savings in coil size in an electronic cooling unit. Maintaining the same air and oil pressure drop through the coil, an Inner-Fin coil equivalent in capacity to a standard finned tube coil occupied 60% less space.

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Why USAF Plans Billions For Defense

by Maj. Gen. Ben I. Funk*

OUR COUNTRY'S TOP PRIORITY defense job today is the Air Force Ballistic Missiles Program. These missiles will be our counterpunch tomorrow, as the manned bomber is now.

We have a goal. We must achieve it. That goal is for the United States to have a completely dependable and fully operational team of ballistic missiles, ready for our protection as soon as humanly possible.

Nothing less will defend us. But in achieving this, the impact of the program upon our national economy will be beyond prediction. Many will be helped. Some few will be hurt. All of us will be affected.

The size and complexity of the problem is staggering. Its solution requires far more than accelerated research and development. We need to do more than simply to accelerate research and development to improve present weapons systems and to design newer, better ones.

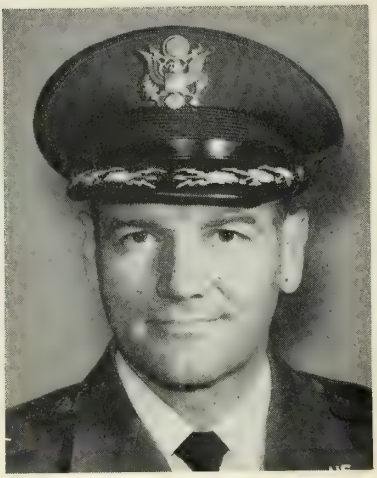
We must, additionally, have the means for necessary production in quantity—tooled, trained and ready. There must be logistic support for R&D, procurement, production, and for operation and training.

The Ballistic Missiles Office of Air Materiel Command has that essential responsibility: for procurement, production, logistic support.

These three functions make up one big assignment. Even now, in its early days, our program has made profound changes in our national industry. It is revolutionizing the entire business of defense. Directly and indirectly it is, even now, involving very many thousands of both large and small firms, and literally uncounted thousands of American wage earners.

• **Billions for defense**—At the money level alone, USAF's ballistic missiles program is spending over $1.3 billion annually for our defense dollars.

It has been less than four years since the first official Air Force order was issued for research and development of an ICBM. This decision was a direct outcome of the thermonuclear breakthrough in 1953, when the making



of a high yield hydrogen warhead small enough for practical missile use became feasible.

Concurrently with the establishment of the Western Development Division of the Air Research and Development Command—today's Air Force Ballistic Missile Division—under the command of Major General B. A. Schriever, the Air Materiel Command set up its Special Aircraft Project Office, now the Ballistic Missile Office.

Thus AMC became a part of the unique management team, which today includes also the SAC-MIKE office of Strategic Air Command, and the Space Technology Laboratories of the Ramo-Wooldridge Corporation.

This management complex, made up of offices from three major USAF commands and an experienced civilian technical firm, is providing, for the first time in military history, a weapons system with skilled direction from the first concept through R&D, procurement, production, creation of test and industrial facilities, the building of launch complexes, the establishment of logistic support, and the training of technical and operational personnel up to the final point where a combat force can take over the missile for actual use.

• **Many take part**—Back in 1954 there were only a handful of people in the ballistic missile program. Today there are more than 2,000 military and civilian personnel, hand-picked for their specialized skills and experience, working literally day and night . . . and the number of people is growing, the working hours keep getting longer. Even for those within the team it is sometimes difficult to comprehend fully the magnitude of the program.

For example, consider our *Atlas, Titan,* and *Thor* missiles. They are built by a number of major associate prime contractors. Convair, Martin, and Douglas are responsible for the air frames and production assembly. Propulsion systems come from Rocketdyne Division of North American Aviation, and from Aerojet-General Division of the General Tire and Rubber Company. Sundstrand furnishes auxiliary power supplies. Guidance and control systems are produced by General Electric, Western Electric, American Bosch Arma, and AC Spark Plug. Burroughs and Remington-Rand build the computers. AVCO and General Electric provide the nose cones.

Fifteen prime contractors are required for these three missiles. One of these primes alone is subcontracting work to more than 8,000 other firms.

Present indications are that about 55,000 workers are employed by prime contractors under the program. To these can be added about 35,000 others, employed by major subcontractors. All are employed by firms that are holding missile contracts. When the second, third, and fourth tier subcontractors are considered, there must be many more than 100,000 American workers directly affected economically.

Geographically, the program is really nationwide. Prime contractors and major subcontractors are located in 25 states and the District of Columbia. They are on the Atlantic Coast, the East, the Midwest, the South, the Southwest, the Farwest, and the Pacific Coast. Lower-tier subcontractors are found in practically every state.

Small business also has a big place

**Ballistics Missiles Manager Air Materiel Command.*

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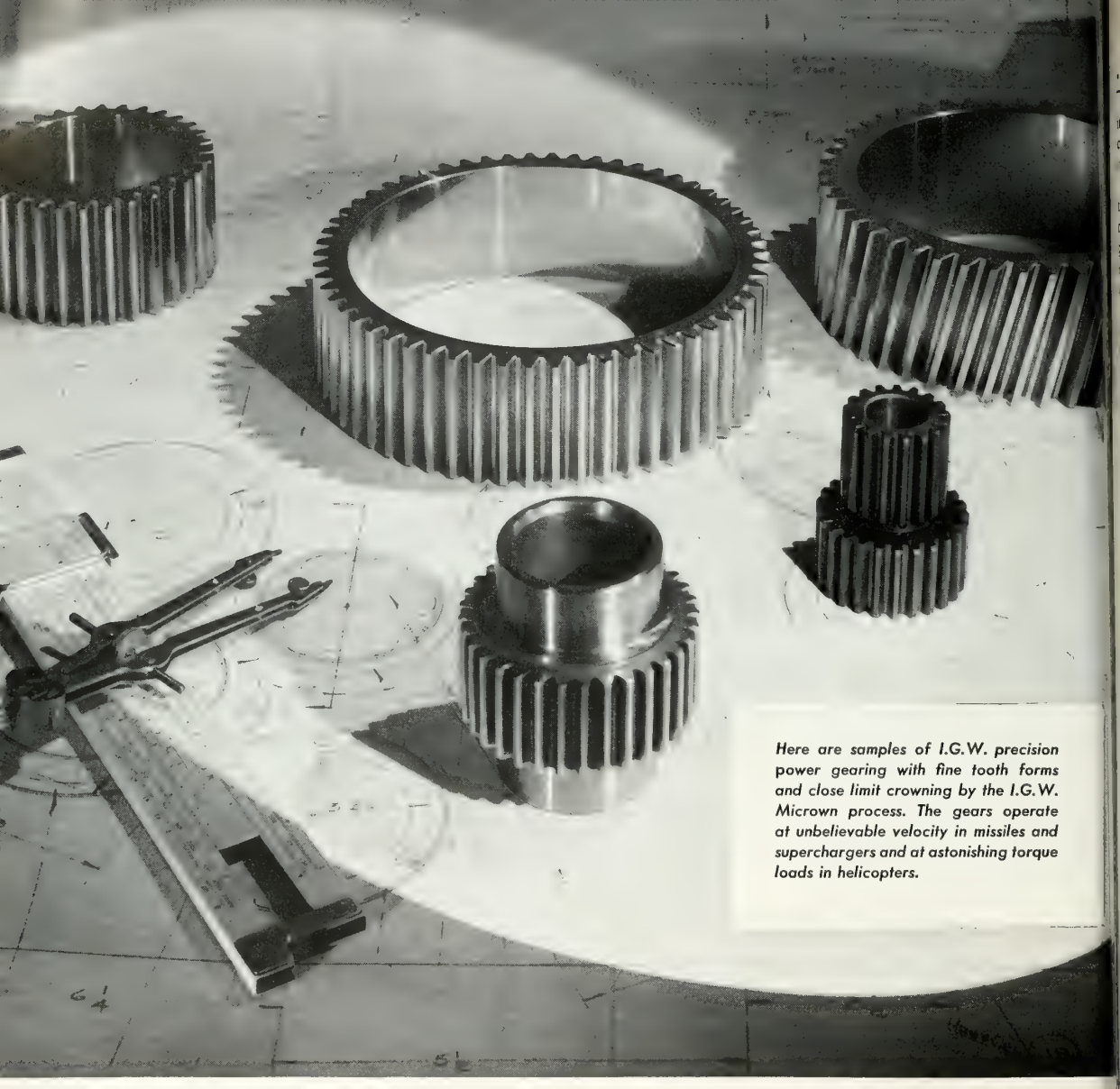
Measuring the bore of a steel liner ground in assembly with the lower housing of the Sikorsky S-56 Helicopter transmission. Its complex, thin-walled casting must be machined with all bores and faces within an angular tolerance of plus nothing and minus one minute and thirty seconds and with linear tolerances of plus or minus .002.

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. . . why USAF plans billions

in the program. Small firms cannot be called neglected, either dollar-wise or in numbers.

There is a common misconception that USAF's big missiles are being made by only a few large aircraft companies. This is simply not so. Many small companies are now participating actively. More will join in the future.

Take the case of Douglas at Santa Monica. Douglas officials are the first to point out that their company has subcontracts to 8,473 smaller businesses, which contribute essential items to the program.

Nowhere in the program is there a case of "one contractor—one weapon."

• **Small business too**—Since our associate prime contractors must team together, it is obvious that they must also call on small concerns to participate. Each needs the other. And Air Force needs them all.

This small business participation is big business in itself. More than 27 cents of every Air Force dollar spent on ballistic missiles is going to small business. That much is known. That amount can be traced. How much more trickles down from sub-sub-contractors is beyond convenient estimation.

Six months ago—as of December 31, 1957—USAF had paid more than $1.3 billion to prime contractors holding contracts for R&D and for procurement and production of missiles. Of this amount, almost 21 percent—$269 million—passed directly from prime contractors to smaller businesses for goods and services. Another 7 percent —$91 million—could be traced to second and lower tier small business contractors. These $360 million equal 27.7 percent of the total AF money spent for ballistic missiles.

At the beginning of the missile program, extensive subcontracting to small business was impractical. There were three main reasons for this.

First, small business was actively engaged in producing the components of manned aircraft, components needed for supplying the production lines rolling out aircraft in quantity. This was a job they knew well, under contracts and circumstances with which they were familiar.

Second, the ballistic missile program was then one of initial research and development, involving new hardware prototypes in small numbers. Quantity production of big missiles was only in the preliminary planning state. The time had not yet come where small business could help the program to advance.

Third, from USAF's point of view, there was security to be considered. R&D was then highly classified. In the national interest it was necessary to hold down the number of persons and companies involved.

Yet even so, small business was getting an indirect share. There was, for instance, the matter of some $450 millions invested in the industrial base for R&D, testing, and production. This included $115 million supplied by prime contractors from their corporate funds, plus $235 million in USAF industrial facilities and public works monies. This spending produced new buildings, new laboratories, new machine tools, and new test centers, equipment, and facilities.

In our free economy it is literally impossible to spend $450 million without many of those dollars going to small firms.

Somebody has to put the windows in the new lab building; it is usually a small glazing firm that gets the job. Somebody has to deliver the special new equipment to the new lab; normally a local trucker does the pick-up and hauling. Somebody has to lay the blacktop for the parking lot; generally a local contractor has the low bid.

Air Force makes very sure that America's vital small companies participate in the ballistic missiles program. Each missile contract carries a clause which requires that the prime contractor do the maximum amount of subcontracting feasible.

AMC's Ballistic Missiles Office now has a separate Small Business Office. This has been set up specifically to assist small companies. It helps fit them into the picture where it will be best for all concerned.

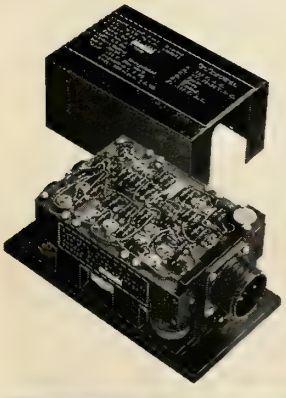
Long before production lines were set up, small business was working on Air Force ballistic missiles. Once full production is established, small business will earn a larger share of defense dollars.

That share, up-to-date, has not been small. Consider these typical examples: Convair is building *Atlas*. About 37 percent—$105 million—of the *Atlas* contract has been subcontracted to almost 2,900 different businesses.

• **Who's doing it**—*Thor* is on the assembly lines at Douglas. Of the overall *Thor* dollars, Douglas has spent 23 percent—$18 million—with more than 8,000 smaller firms.

Martin is building the *Titan*. More than 1,500 small companies will earn 27 percent—$35 million—of the *Titan* contract.

NEW LIGHT-WEIGHT STATIC INVERTER PROVIDES SINE WAVE POWER



Advanced transistorized circuitry design has enabled JORDAN ELECTRONICS to produce sine wave power inverters with 100 VA, 150 VA and 500 VA outputs in units as small as .033 cu. ft. and weighing only 3.6 lbs.

The 150 VA 800 cps unit shown, provides 115 V single phase output. Regulation is ±2.5% or better with load varying from 0-100%, input voltage 26-30 V DC and mounting base temperatures ranging from −55°C to +85°C. The efficiency is 60% minimum under above conditions. Input surges to 40V can be handled. The distortion is less than 5% and the frequency tolerance is only ±2.5%. A self-resetting "electronic circuit breaker" protects the unit from overloads, including short circuits.

Other models now in production supply 3 phase power at 115 V 400 cps with outputs of 100 VA and 500 VA. Outputs up to 1 KVA and frequencies of 800, 1000 and 1600 cps can be supplied.

JORDAN ELECTRONICS also supplies transistorized DC-DC Converters, Timers, Voltage and Frequency Sensors, Keyers and Flashers for aircraft and missiles.

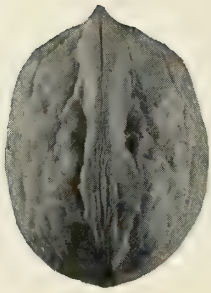
For detailed specifications, write:

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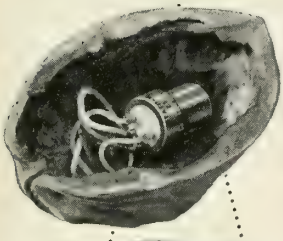
a division of THE VICTOREEN INSTRUMENT COMPANY

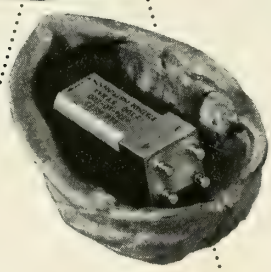
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miniaturization in a nutshell





* **STATHAM MODEL P222** flush diaphragm pressure transducers. DIMENSIONS: .25" diameter x .47" long. WEIGHT: 3 grams, approximately. RANGES: 0-10 to 0-200 psia, psig, or psid; ±5 to ±25 psid. NON-LINEARITY & HYSTERESIS: Not more than ±1% fs. TRANSDUCTION: Resistive, complete bridge; Statham unbonded strain gage.

* **STATHAM MODEL A52** linear accelerometer. DIMENSIONS: .32" wide x .35" high x .84" long. WEIGHT: 8 grams, approximately. RANGES: ±5 to ±100 g. NON-LINEARITY & HYSTERESIS: Not more than ±1% fs. TRANSDUCTION: Resistive, complete, balanced bridge; Statham unbonded strain gage.

Statham's accurate, reliable line of pressure transducers and accelerometers are designed to meet the exacting requirements of today's missile and supersonic aircraft programs. Let us assist you with your instrumentation problems.

*Model shown actual size.

Complete data are available upon request.

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. . . USAF plans

Propulsion systems for *Atlas, Thor,* and *Jupiter* are being built by Rocketdyne. About 4,000 small business are getting 20 percent—$45 million—of the Rocketdyne contract.

R&D and procurement and production have taken a major share of the amounts spent on ballistic missiles so far. Now, with our missiles approaching operational status, something new is looming on the economic horizon.

This is the logistic support question.

Operation and maintenance of missiles is far more difficult than that demanded by manned aircraft. And logistic support is more important to the ballistic missile than it is to any weapon ever developed by man.

Part of this is due to the time-compression inherent in missile warfare. Even our fastest jets take long hours to reach far-off targets. A missile spans the same distance in short minutes. Speed and precision are more important than ever before. Both are costly.

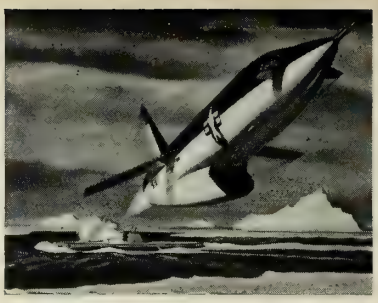
Reliability has become a critical factor. Once a missile is fired, nothing can be done to correct mistakes or omissions made on the ground before the launching. Supply and servicing create problems never before encountered, let alone solved. Completely different methods of determining needs and supplying parts, material and labor are required.

• **Ground support**—Then there is the disproportionate cost of ground support. If, for example, there are ten *Atlas* missiles at a launching site, their value will represent less than 20 percent of the total site cost. Spare parts will come to another 10 percent. Technical facilities will represent 30 percent. And 40 percent of the dollars invested will be in ground support equipment.

Logistic problems for AMC are more than doubled in this new age of missiles. Both manned aircraft and ballistic missiles must be supported to the fullest extent possible. Automation and electronics have been called in to help solve this puzzle.

Within a few months, in our Directorate of Ballistic Missiles at Norton Air Force Base near San Bernardino, a new AMC system will be in full operation.

As the brain of this system there will be an Electronic Data Processing Center. Here a giant computer will be linked, by a separate communications net, to the operations and logistics sections of our working missiles. Operating squadrons, storage sites, contractor supply and maintenance, and Air Force



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Projects involve advanced guidance and control and fire control systems for missiles and high-performance manned aircraft. They begin with investigations and theory and progress through systemization and packaging to detailed hardware design. Key responsibilities await additional men who are qualified in these areas. Advanced degrees preferred.

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Fire Control and Microwave Systems Engineer. Requires E.E., or Physics Degree; at least 2 years experience in radar, data link, or fire control systems; and strong ability in this work.

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Vought Vocabulary

in′ge·nu′i·ty: *designing a 12-ton missile to fit inside an atomic sub*

Chance Vought's *Regulus II* missile is twice as long as a city bus. It is crammed with delicate instruments, armed with a nuclear warhead. Yet Vought engineers designed *Regulus II* to serve safely, efficiently aboard the Navy's newest nuclear-driven submarines.

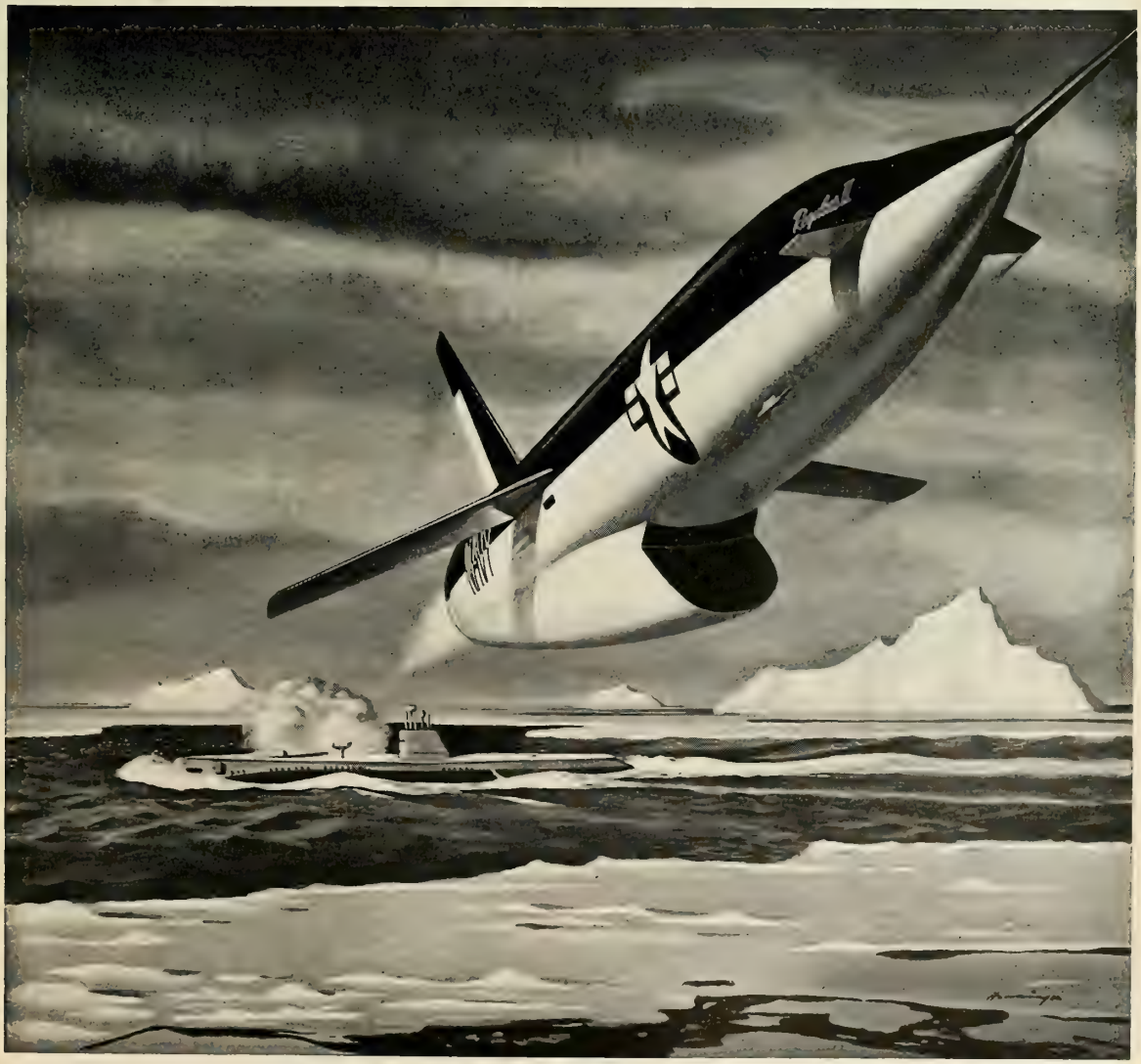
They shock-proofed the missile against underwater blasts. They conditioned it for polar ice, or equatorial heat. They made it — like Vought's smaller Fleet veteran, *Regulus I* — a dependable weapon, accurate from conventional or nuclear subs, from surface ships or highly maneuverable, mobile shore launchers.

Aboard its special, globe-girdling sub, *Regulus II* will move *invisibly* any distance to its launching point. There it can begin a supersonic, long-range strike in minutes. Or it may lurk unseen for months as a patient and ready deterrent.

A chilling prospect for would-be aggressors, this example of Vought ingenuity.

Scientists and engineers: pioneer with Vought in new missile, manned aircraft, and electronics programs. For details on select openings write to: C. A. Besio, Supervisor, Engineering Personnel, Dept. PP-6.

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IMPORTANT:

In the Autocal, pressure is applied *dynamically* using continuous readout (not statically with stepwise readout). Only the Autocal simulates *actual* transducer operating conditions; it reveals much more about transducer operational behavior than any other method. To improve the reliability of your pressure measurements, write for full details on the Autocal 10A.

Write for your copy of the Autocal design report



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. . . USAF plans

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This will provide worldwide inventory control with a speed and precision beyond the capability of human supply clerks. Determination of requirements, budget/buy computations, and resupply of needed items will be nearly automatic.

Without the Electronic Data Processing Center and its system, our missile support program could bog down in endless paper work, result in mountains of unused parts, and tie up uncounted manhours. With EDPC we can meet the logistic demands of the missile age.

In the process of developing missile support systems, we should discover new concepts and methods which could prove of great value to American industry.

The Air Force ballistic missiles program promises to be one of the most radical developments we have seen. The coming of steam power, of electricity, of internal combustion engines, and of electronics and atomics, all made vast changes in our world. Missiles can prove as important as any of these.

Missiles are much more than just new weapons. The rocket, like the airplane, is a revolutionary vehicle. It is opening up an absolutely infinite new field as a transportation and communications tool for mankind.

Big as the program is now, it will be bigger in the future. It must be so. Missiles are the future.★

Space Agency Bill Awaits Presidential Okay

The House and Senate last week quickly approved and sent to the President, the compromise bill setting up the new civilian National Aeronautics and Space Administration. The new agency, using the National Advisory Committee on Aeronautics as a nucleus, will function under a nine-man council headed by the President and an administrator with broad powers. The administrator will be appointed by the president. Dr. Hugh Dryden, current head of NACA, is the man named most likely to get the nod.

The bill in its final form had a provision deleted which would have provided insurance of contractors working on space projects, but House Majority Leader John McCormack, who is also chairman of the House space committee, inferred that new legislation may be forthcoming. The bill also provides that small business "will be able to participate equitably" with the industrial bigs, and grants certain commercial patent rights to industry.

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Progress Report:

Science

ENORMOUS PROGRESS has been made last year in our large ballistic missile programs, and an increasing rate of activity promises even more reassuring and gratifying results in the period ahead.

We have by now had such repeated and definitive confirming scientific data on all of the techniques and fundamental design points—on structures, propulsion, re-entry, and on guidance and control—as to leave no doubts concerning the scientific basis for our large missile technology and plans now in progress.

We have also had enough success in our first year of full-scale flight tests as to be able to carry every part of the program into the design-finalizing and reliability-improvement operation phase.

• **Missile age preparation**—We have been preparing for this final phase on a scale without previous precedent. A mere handful of missiles turned out in a year can hardly act as a deterrent against an aggressor nation, nor should we be frightened by such a capability in their hands.

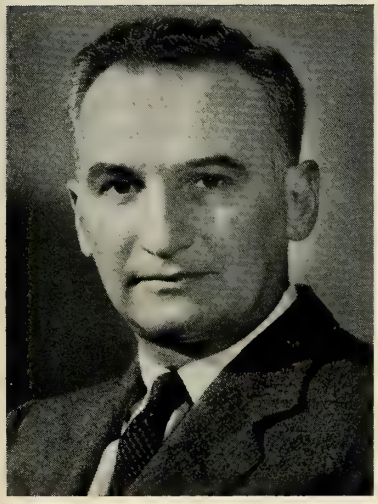
What is needed is much more than a scientific demonstration to show that these things can be done, and that a practical embodiment is possible. A substantial number of missiles is needed, standing ready, with high reliability inherent in their detailed design; with training and handling programs that have reached positive and tested fruition; with logistics, spares and maintenance backup's. Only such an operational capability as described is meaningful.

But to attain these things means large quantities of hardware to make possible the detailed product development of each component, and to provide assurance of proper design when these components interact in major subassemblies.

We need a vast amount of component testing, analysis, and detailed design refinements. Over-all systems tests, both "hold-down" or captive, and flight tests are required covering a wide range of conditions which might exist

Boosts Ballistic Missiles

by Simon Ramo*



for various flight operations.

• **Present production**—To make possible such a scale of operations, the Air Force program on *Thor, Atlas,* and *Titan* had to be broadly planned from its inception, and long leadtime steps taken well before the design could be jelled.

Today every subsystem, be it guidance, re-entry nose cones, or rocket engines, is pouring from production lines.

Every flight test that has been made has involved equipment from these lines. When a missile flight is analyzed, or a static stand's results are investigated, the considerations include not only the fundamental design, but the relations of function to manufacturing tolerance, quality control of factories, check-out procedures, and simultaneous development of all of the measuring apparatus involved in the operating procedure.

In developing missiles, we are also developing the industry, the facilities, the capability of reproduction of hardware, and the teams and procedures in operation.

Even the test flight range itself is being pioneered as to its sophistication, as well as its distance, by these large programs. Every test result enables us to take another step in the tightening up and bedding down of this large complex of men and machines.

• **Future capability**—The period immediately ahead will see demonstrations to the fullest ranges and the highest accuracies of the largest payloads of which these systems are capable. It will also see the completion of the creation of a major new technology in the U.S. With this industry established, and with the engineering techniques firmly rooted, the U.S. will then be in a position to take other steps into space, based on the availability of really large boosters.

By engineering extensions that in themselves will be much more straightforward than has been true of the first steps in providing for a truly long-range ballistic missile capability, we shall be able to launch with reliability and relative ease heavy payload satellites. We shall also be able to do a great deal in pursuing bio-medical space experiments; Lunar, Martian, and Venusian probes; and even commence the many steps of making man a space traveler.

**Dr. Ramo, president, Space Technology Laboratories (a division of the Ramo-Wooldridge Corporation), is also a member of the board of directors of Thompson Products, Inc., and of Pacific Semiconductors, Inc. The Space Technology Laboratories has over-all technical supervision and weapons system engineering responsibility for the USAF Ballistic Missile Program, including the intercontinental* Atlas *and* Titan, *as well as the intermediate-range* Thor *ballistic missiles. Dr. Ramo is "chief scientist" of this program. He is also author of two major textbooks widely used in the nation's universities and by practicing engineers: "Fields and Waves in Modern Radio" and "Introduction to Microwaves." Dr. Ramo teaches several graduate courses at the California Institute of Technology for doctorate students.*

FOR THE NAVY'S VANGUARD
STAINLESS STEEL FOR HEAT RESISTANCE



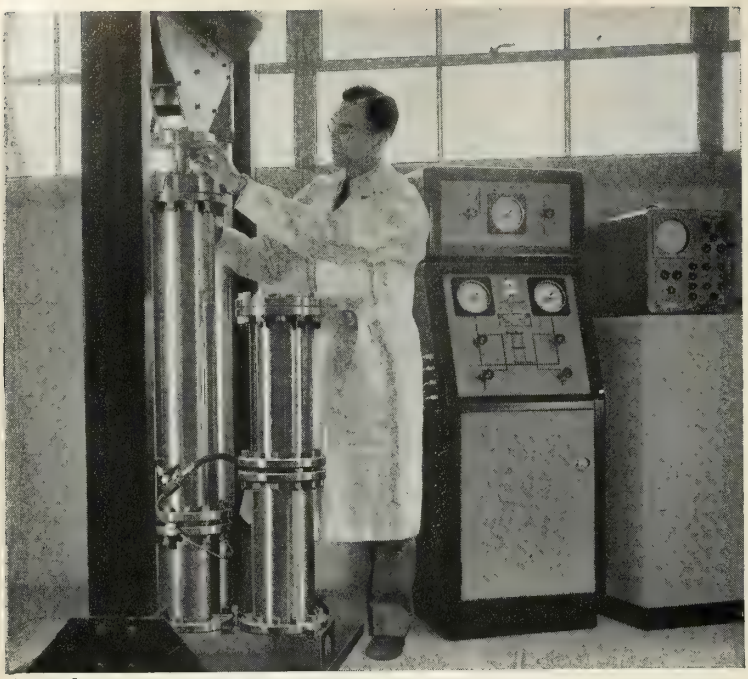
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Rochester Division, Rochester 3, N. Y.

SALES AND SERVICE OFFICES IN PRINCIPAL CITIES

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contracts

NAVY

By District Public Works Office, Eleventh Naval District:

Cory and Longworth Inc. received $465,000 for construction of interim guided missile facility.

Manco Construction Co. received $291,100 for construction of turbo-jet engine test cells, naval air missile test center.

AL-CO Co., Inc. received $961,452 for construction of various bldgs., Naval missile facility.

James Stewart Co. received $162,950 for construction of guided missile support facility.

By Naval Research Laboratory:

Royal McBee Corp. received $51,740 for digital computer.

Bendix Computer Division, Bendix Aviation Corp., received $82,799 for medium speed digital electronic computer system.

By Bureau of Ordnance:

Corning Glass Works received $400,000 for production of Pyroceram missile radomes.

Bjorksten Research Laboratories received $75,000 for research on low-fluidity refractory materials.

Cornell Aeronautical Laboratory received $49,718 for research of ceramic materials.

By Bureau of Ships:

Control Data Corp. received $600,000 for large-scale computer of advanced design.

ARMY

By Purchasing and Contracting Office, Engineer Research and Development Laboratories:

LOX Equipment Co. received $47,789 for LOX 25-ton trailer.

Charles Payne & Associates received $53,816 for study and design of one horizontal standby shelter, *Jupiter* system.

By Engineer District, Mobile, Corps of Engineers:

Butler & Cobbs received $194,877 for construction of interim test facility for solid propellants at Redstone Arsenal.

By Engineer District, New York, Corps of Engineers:

Vincent J. Licata received $195,419 for construction of rocket storage checkout and assembly building addition.

By Boston Ordnance District:

National Research Corp. received $74,680 for research and development study.

Sylvania Electric Products, Inc. received $99,995 for research and development study.

By Engineer District:

Robert E. McKee, General Contractor, Inc. received $642,300 for flight determination laboratory; $624,650 for communications building laboratory; $2,326,800 for radar park facilities.

Hugh McMillan, Inc. received $111,136 for ABMA instrumentation facilities.

By Engineer Division, New England Corps of Engineers:

Manzi Electric Corp. received $64,136 for construction of flood lighting and alarm systems for *Nike* batteries.

By Purchasing and Contracting Div., White Sands Missile Range:

Bendix Pacific Div., Bendix Aviation Corp., received $199,263 for digital meteorological data measuring and logging system.

American Machine and Foundry Co. received $229,880 for targets.

Lee Electric Construction Co. received $23,998 for power facilities for FPS-16 radar unit.

Wayne George Corp. received $116,000 for digital data recorder.

Brush Instruments Div., Clevite Corp., received $67,725 for recording systems.

By Engineer District, Kansas City, Corps of Engineers:

Martin K. Eby Construction Co. received $5,659,696 for construction of four *Nike-Hercules* missile areas; $93,900 for construction of rocket storage.

ENGINEERS

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. . . contracts

By Ordnance Missile Command:

Birmingham Gas Heating and Air Conditioning Co., Inc. received $86,774 for installing a high and low temperature conditioning system for testing large jatos at various temperatures.

Radio Corp. of America received $321,922 for complete closed circuit television system.

By Purchasing Division, Quartermaster Activities, Cameron Station:

R. E. Lee Electric Co. Inc. received $37,210 for installation of combination tactical alert-fire alarm systems at *Nike* sites.

By Engineer District, Chicago, Corps of Engineers:

Siesel Construction Co. received $699,743 for construction of additional facilities at special AAA sites.

Lee Construction Co., Inc. received $766,000 for construction of additional facilities at special AAA sites.

Siesel Construction Co. received $711,434 for construction of additional facilities at special AAA sites.

Fischbach, Moore & Morrissey, Inc. received $50,732 for construction of anti-intrusion system at special AAA sites.

Abbot Construction Co. received $251,882 for construction of *Nike* guided missile field maintenance shop.

By Engineer District, Philadelphia:

Malan Construction Corp. received $2,204,123 for construction of conversions with related site improvements and utilities at 12 special AAA sites.

By Corps of Engineers, Office of the District Engineer, San Francisco District:

Newbery Electric Corp. received $32,580 for modifications and improvements to launcher areas.

By Corps of Engineers, Office of the District Engineer, Washington:

Grunley, Walsh & Blanche, Inc. received $815,214 for construction of modification of tactical facilities at *Nike* sites.

Malan Construction Corp. received $350,558 for construction of modifications of tactical facilities at *Nike* sites.

Thomas W. Yoder Co. Inc. received $519,523 for construction of modifications and conversion of tactical facilities at *Nike* sites.

Tuckman-Barbee Construction Co., Inc. received $246,700 for construction of *Nike* guided missile field maintenance shop at Fort Belvoir.

By Ordnance District, Los Angeles:

Gilfillan Bros. Inc. received contracts totaling $189,928 for depot replenishment repair parts for the *Corporal* missile system.

Firestone Tire & Rubber Co. received $163,000 for replenishment repair parts for guided missile, artillery M2 and related ground handling equipment.

Townsend Engineered Products received $59,895 for design and development of a ground fire suppression kit for helicopters.

Aerophysics Development received $49,334 for *Dart* antitank guided missile.

Douglas Aircraft Co., Inc. received $68,900 for repair parts for *Nike* system; $95,000 for supplies and services relating to the *Honest John* missile.

Telecomputing Corp. received $38,147 for warhead testers.

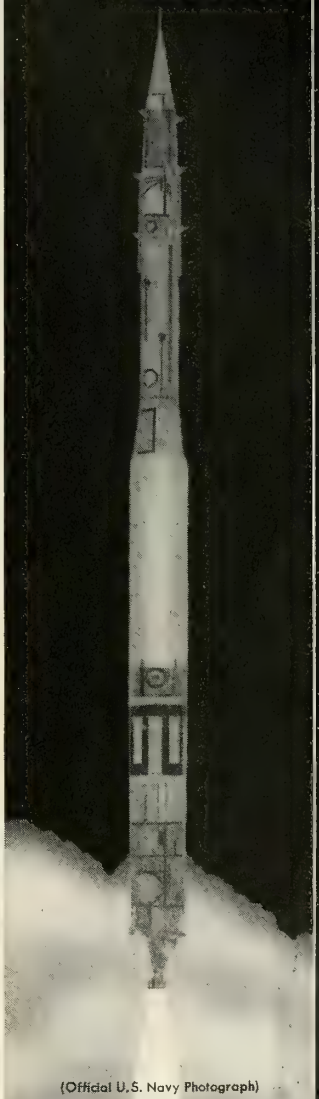
Hallamore Electronics, a div. of the Siegler Corp. received $43,066 for microlock test receivers.

Aerophysics Development Corp. received $44,000 for study reports for drop test of *Jupiter* nose cone.

Aerojet-General Corp. received $114,727 for study and design for a new missile systems test facilities for solid propellants; $296,937 for installation of instrumentation and control system in ABMA test facility area.

University of California received $27,046 for studies of natural and induced radioactivities.

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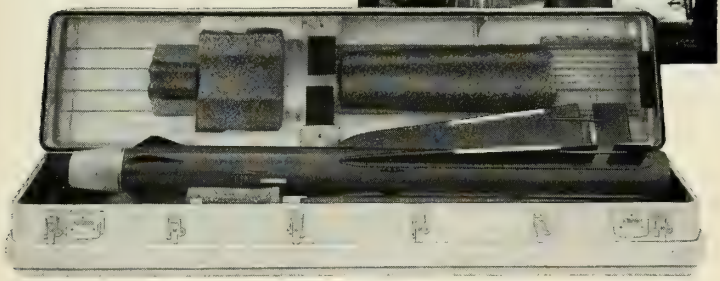
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. . . contracts

By U.S. Army Ordnance Missile Command, Redtsone Arsenal:

Packard Manufacturing Co. received $25,177 for jato units XM37 metal parts.

E. I. Du Pont De Nemours & Co. received $33,876 for hydrogen proxide.

Thiokol Chemical Corp. received $560,492 for continuation of research in the field of solid propellant rocketry.

By Purchasing and Contracting Officer, Engineer Research and Development Laboratories:

Perkin-Elmer Corp. received $29,507 for reflectance spectrophotometer.

Armour Research Foundation received $39,166 for research study on nitrogen generating processes.

Alco Products, Inc. received $70,952 for design study of twenty-five megawatt pressurized light water reactor system.

By Picatinny Arsenal:

Nuclear Products, Erco Div., ACF Industries Inc. received $37,114 for development and fabrication of warhead unit assembly dolly, XH-4104 for the *Jupiter* guided missile.

By U.S. Army engineer district, Philadelphia:

The Ferber Co. received $327,915 for construction of conversion to *Hercules* and site improvement at special AAA site.

By Engineer District, Pittsburgh:

C. F. Mayer & Co. received $291,727 for *Hercules* conversion and elevator improvements at launching area.

Monroe Tree Surgeons, Inc. received $28,270 for masking area clearing at special AAA site.

By U.S. Army Engineer District, Los Angeles, Corps of Engineers:

Price-McNemar Construction Co. received $97,000 for conversion to *Hercules* at special AAA site.

By Engineer District, Detroit, Corps of Engineers:

Roth, Wadkins & Wise, Inc. received $570,396 for construction of supporting tactical facilities at special AAA sites, including all related work necessary.

By Engineer District, Jacksonville, Corps of Engineers:

Biltmore Construction Co. received $206,855 for construction of rocket storage.

By Engineer District, New York, Corps of Engineers:

Hall Construction Co. Inc. received $1,407,747 for conversion, *Nike Ajax* to *Hercules.*

Nassau Construction Co., Inc. received $1,379,440 for conversion, *Nike Ajax* to *Hercules.*

By Corps of Engineers, Office of the District Engineers:

W. Harley Miller, Inc. received $116,634 for construction of storage base rocket and assembly addition at Andrews AFB.

Reid, Inc. received $258,976 for construction of guided missile support building at Fort Belvoir.

By Engineer Division, New England Corps of Engineers:

Blount Brothers Construction Co. received $8,560,445 for construction of missile facility FY-58.

J. R. Cianchette received $6,814,744 for construction of missile facility.

Conyers Construction Co., Inc. received $254,987 for construction of alterations and additions to *Nike* batteries.

John A. Volpe Construction Co., Inc. received $8,684,862 for construction of missile facility.

The Portland Co. received $54,416 for improvements of elevators at *Nike* batteries.

By District Engineer, U.S. Army Engineer District:

Allen M. Campbell Co. received $123,008 for special projects laboratory; $331,231 for missile assembly bldg.

The Costanza Construction Co. received $570,694 for special AAA conversion for *Nike-Hercules* sites.

Gowdy & Durkin, Inc. received $189,600 for construction of nitrogen distribution system, Part III, and carbon dioxide system for the supersonic circuit of the propulsion wind tunnel, Arnold Engineering Development Center.

Pearce and Gresham Co. received $326,773 for construction of misc. ABMA projects at Redstone Arsenal.

R. D. Lowman, General Contractor, Inc. received $1,149,411 for guided missile training facilities.

Hugh McMillan, Inc. received $260,722 for guided missile training facilities.

C. L. Castor Construction Co., Inc. received $479,019 for guided missile training facilities.

By Signal Supply Agency:

Polytechnic Institute of Brooklyn received $32,190 for research work on "thin-film of ferrimagnetic oxides."

American Electronic Labs, Inc. received $48,045 for research work on wide band, wide open spectrum analyzer.

Princeton University received $132,000 for research work leading to the determination of the relationship between the fundamental structure and the physical, electrical, mechanical and chemical properties of high polymers.

General Ceramics Corp. received $94,502 for research to conduct research investigation toward development of high frequency core materials by the synthesis of ferrites.

Polytechnic Institute of Brooklyn received $45,410 for research work towards the investigation of chemical bond type by measurement of electron distribution.

Radio Corp. of America received $125,820 for research to conduct a study and investigation for the purpose of developing transistorized radio relay systems.

Radio Corp. of America received $394,727 for study and investigation of a radio frequency rec. group.

Belock Instrument Corp. received $366,284 for antenna control equipments.

General Electric Co. received $87,676 for additional research study on development of electrical output recording storage tube.

Eastman Kodak Co. received $46,831 for research and development work continuing the investigation directed toward demonstrating feasibility of AVA batteries.

Radio Corp. of America received $90,000 for studies and surveys in the field of electronic component parts and materials.

American Electronic Labs., Inc. received $25,085 for untuned broad band crystal modulator covering frequency range from 50 mc to 12,000 mc.

Polytechnic Institute of Brooklyn received $60,000 for additional research and development to study theoretical investigation of transmission line formulation of semi-conductors.

Massachusetts Institute of Technology received $900,000 for research work on basic and applied research in the fields of electronic physics, molecular physics.

University of Pa. received $41,280 for research and experimental work in connection with "the effect of structure on the properties of stable organic free radicals."

Syracuse University Research Corp. received $275,600 for research work to conduct a study and experimental investigation of radar sensors and associated devices.

Gilfillan Bros., Inc. received $182,678 for installation kits for radar set.

By Springfield Ordnance District:

Roth Laboratory for Physical Research received $41,827 for research and development of ultrasonic methods of inspection.

By Engineer District Mobile, Corps of Engineers:

Maurice H. Connell & Associates, Inc. received $42,600 for architect-engineer services in connection with static test facilities at Redstone Arsenal.

AIR FORCE

By Ogden Air Materiel Area:

Boeing Airplane Co., Pilotless Aircraft Div., received $191,935 for technical data for IM-99 missile components.

By Wright Air Development Center:

Fairchild Guided Missiles Division, Fairchild Engine and Airplane Corp., received $300,000 for financing the preliminary development phase of a new airborne avionics system.

By San Antonio R&D Procurement Office, Wright Air Development Center, Air Research and Development Command:

American Institute for Research received $34,061 for improving adjustment of personnel assigned to isolated sites and development of indoctrinated procedures.

Miami Heart Institute, Inc. received $26,534 for additional research and delivery of research reports on plasmapheresis methods research project.

Southwest Research Institute received $28,817 for research and reports on radiation induced free radicals in chemical and biological systems.

By AFFTC, ARDC, Edwards AFB:

Electronic Engineering Co., of Calif. received $35,000 for installation of central data processing station.

Stanley Aviation Corp. received $99,468 for development of water brake and test vehicle.

Mine Safety Appliances Co. received $47,605 for development of an atmospheric monitoring system.

By HQ, 3610th Navigator Training Wing:

Convair Div. of General Dynamics Corp. received $1,718,645 for *Terrier* guided missile shipping containers.

By HQ, AFMTC, ARDC:

General Dynamics Corp. received $186,650 for design and fabrication of reference wave guide system and other spare parts for *Azusa Mark* I.

Dynatronics, Inc. rceived $75,835 for elevated balloon telemetry antenna system.

Milgo Electronic Corp. received $20,669 for modification kits for model 111 firing sequencers.

Convair-Astronautics received $585,152 for increase in equipment.

Milgo Electronics Corp. received $59,411 for increase in funds.

General Dynamics Corp., Convair Division, received $32,059 for increase in funds.

Westinghouse Electric Corp. received $188,000 for increase in funds.

LAST MINUTE AWARDS:

Avco's Crosley Division received a contract of $5-million for defense orders and supplemental funding for an existing contract, all related to ground radar . . .

Crosley also received $8,500,000 worth of defense contracts involving a major component for *Polaris* . . .

Boeing Airplane Co. gave to Fischbach & Moore, Inc. and Tellepesen Construction Co. $3,500,000 for installing mechanical and electronic support equipment in first tactical *Bomarc* missile base . . .

Norden-Laboratories Division of Norden-Ketay Corp. gave to Ryan Aeronautical Co. approx. $1-million for production line of company's ground velocity systems . . .

Army gave to Siegler Corp. $500,000 for constructing three tracking stations for the *Explorer* satellite . . .

Air Force gave two contracts totaling $807,757 to Motorola Western Military Electronics Center for design and fabrication of prototype C-band missile radar beacons . . .

Navy gave two contracts totaling $1,268,889 to Telecomputing Corp. for advanced electronics equipment . . .



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Sputnik Rocket Fell in Mongolia

Contrary to Soviet claims that some remnants of *Sputnik* I's rocket fell on U.S. soil in Alaska and in the Northwest, and that we failed to cooperate with the Soviets by not delivering these unburned remnants, the final verdict of American scientists is that "the probable point of impact" of the first Soviet satellite rocket as it fell and burned was "at latitude 45° N. and longitude 106° E. in Outer Mongolia."

This finding, based on a series of careful observations and reports, is presented in a brief paper entitled "Fall of the *Sputnik* I Rocket" by R. Jastrow and I. Harris of the Nucleonics Division of the U.S. Naval Research Laboratory.

They state that their "analysis is based on several observations of the altitude of the satellite during the last five days of its lifetime. Our calculations lead us to the conclusion that 1957 Alpha 1 fell on December 1 at 0846 GMT, approximately eight hours after the last radar observation made on it in the U.S."

On December 8, one week after the fall of the Soviet carrier rocket, Alexander N. Nesmeyanov, president of the Soviet Academy of Sciences, sent an inquiry to Detlev Bronk, president of the National Academy of Sciences, on the subject of the fallen rocket. A similar cable was sent December 9 by Academician Ivan P. Bardin, president of the Soviet IGY Committee, to Dr. Joseph Kaplan, chairman of the U.S. National Committee for the IGY.

In reply, Dr. Bronk assured Dr. Nesmeyanov that "our review thus far of sightings and trackings of satellite, and investigation or reports of objects sighted, do not indicate rocket or remnants fell in the U.S. or its territory." Now, the Jastrow-Harris report gives the final answer to the Soviet inquiry, proving beyond doubt that the rocket's remnants fell in Red territory, not ours.

Fixed Spending Ceilings For DOD Reconsidered

The Senate Appropriations Committee has cleared the way for reconsideration of legislation that would authorize the President to propose, and Congress to concur in, fixed annual spending ceilings for the Defense Department and other government agencies.

The Senate has already approved an amended version of HR 8002, simultaneously rejecting a move by Chairman Carl Hayden (D-Ariz.) to limit the legislation to the Department of Defense. Amendments to the bill were accepted on a roll call vote.

Although the spending-ceiling legislation was opposed by large segments of industry, most spokesmen preferred HR 8002, which does not basically alter the present method of appropriating money, as would the Senate-passed bill, S434, a much sterner measure.

The Senate bill, would authorize the President to fix a proposed annual spending ceiling when he submits an agency's budget. He would have to determine if the agency has an accounting system capable of handling the accrued account. House and Senate Appropriations Committee may then fix the limit to be spent in that particular fiscal year.

Backers of the bill anticipated no difficulty in getting Senate passage of the bill, since the tougher S 434 Kennedy bill sailed through unopposed last year. Defense and aircraft industry spokesmen filed their views on the bill, most of whom opposed it. Donald Douglas, Jr., president of Douglas Aircraft, said he is firmly convinced "this type of legislation will not bring fiscal improvements."

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Soviet Affairs

by Dr. Albert Parry

The Soviets certainly have their equivalent of our *Nike*, but they are not advertising it. A striking example of this reticence is the recent issue of KRASNAYA ZVEZDA (The Red Star), the chief daily newspaper of the Ministry of Defense of the USSR.

Devoted almost entirely to the troops of Baku on the Caspian shore, a foremost Red oil center in the Caucasus and an otherwise strategic point of prime importance, the issue stresses the Soviet commands concern over that area's defense, yet says not a word about any missile installations around Baku.

Colonel General V. Ivanov, commander of the Baku military district, writes about the rocket-launching sites being built by the U.S. "on the territories of certain states, undoubtedly aimed against our Fatherland and other socialist countries."

He implies that American missiles are aimed against his military district of Baku, and among his own measures of defense he lists fighter-planes, anti-aircraft guns and other services—all except ground-to-air missile installations.

The front page of this particular issue of KRASNAYA ZVEZDA features a Soviet artist's pen-and-ink drawing, detailed and large, representing Baku and its defenses. Prominent in the drawing are Red fighter-planes in flight and poised anti-aircraft guns, but missile batteries are completely absent. In his article, General Ivanov reveals that Baku's massive anti-aircraft batteries, while training, score two hits out of every five salvoes. According to the general, this is a respectable record, but, if any missile batteries are interlarded with such conventional guns, their records are not indicated.

The Red side also continues to deny the existence of any Soviet rocket-launching sites on the soil of the so-called "people's democracies" west of Russia's borders. Yet, reports a traveler recently returned from Poland, the presence of a large Soviet military mission in Warsaw is commonly explained by Poles in these words: "The Russians are building rocket bases."

The traveler adds the paradoxical observation that, hating the Russians as the Poles do, the Poles nevertheless welcome Russian rocket bases on their soil. For the Poles hate the Germans even more than they hate the Russians.

In their view, the Soviet rocket bases will defend Poland in case of attack.

Everywhere in the Soviet dominated belt of Eastern and Southern Europe, Communist governments keep on declaring that they have no rocket bases on their soil, but that they would install them should Western powers build such bases in Western and Central Europe. The latest "satellite" to make this announcement is Albania.

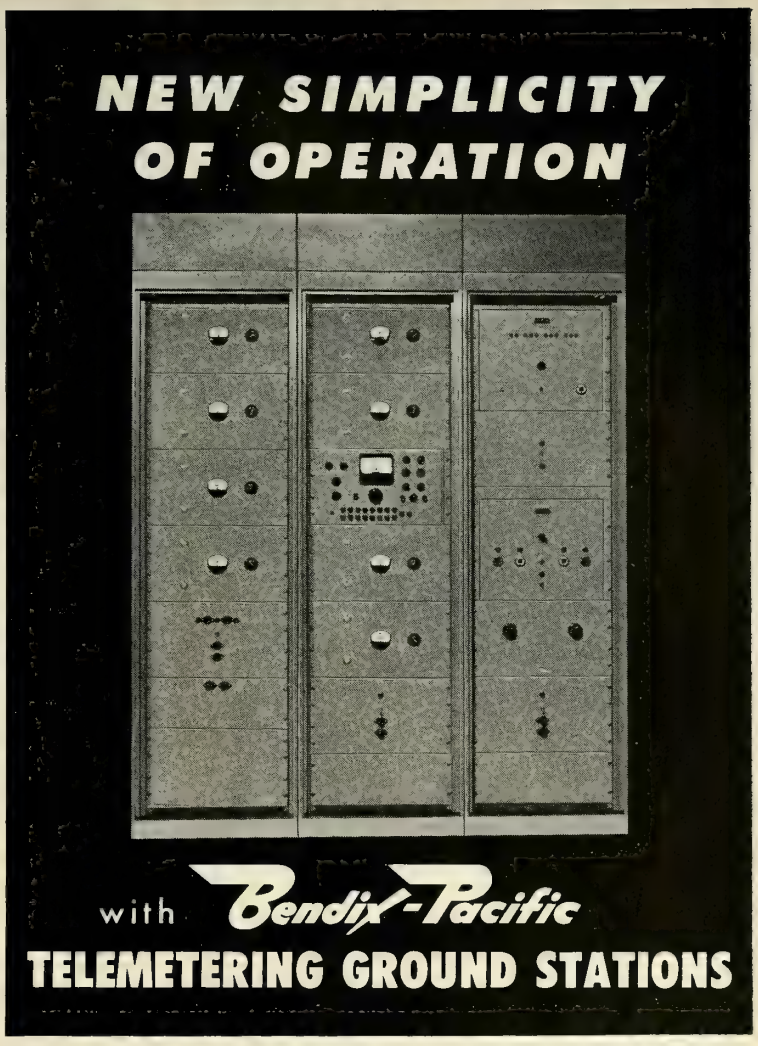
Should Italy allow the U.S. to install its rocket bases on Italian soil, this would constitute a breach of the Italian-Albanian peace treaty, and the Red government of Albania would then erect rocket bases on its territory. Such is the warning issued by the Communist government at Tirana in a formal note to the Rome government—on orders from Moscow, of course.

From the moment of its initial orbiting on May 15 and up to July 1, *Sputnik* III covered "more than one half of the distance between the Earth and Mars, when they are farthest apart." So stated Professor B. V. Kukarkin, vice-president of the Astronomical Council of the Soviet Academy of Sciences. He also related that *Sputnik* III became first visible from Soviet territory on June 13, or nearly one month after its launching.

From June 13 to June 30, inclusive, Soviet watchers noted 147 passings of the carrier rocket and 90 passings of *Sputnik* III itself. Best observations were made by astronomers and lay-watchers in Moscow, Smolensk, Chernovtsy, Kharkov, and (in Eastern Siberia) at Komsomolsk-on-Amur and Blagoveshchensk. In all, 80 stations in the USSR and nearly 30 stations outside the USSR participated in the observations and reports on *Sputnik* III.

Visual observations showed that both *Sputnik* III and its carrier rocket changed their brightness considerably while in flight. At its most brilliant, the rocket was brighter than any star and could be likened only to Jupiter. At such moments *Sputnik* III was as visible as a star of the Great Bear (Ursa Major).

"We are on the eve of solving the mystery of the Tungus Meteorite," V. Lutsky, a lecturer at the Moscow Planetarium, announced in IZVESTIA. This summer, a new expedition of the Soviet Academy of Sciences is working in East Siberia, investigating the puzzle of the famous Tungus Meteorite which struck the area of the Podkamennaya Tunguska River 50 years ago, laying waste a huge expanse of forest but leaving hardly any vestiges of its own body. The findings of the current expedition are awaited with interest.



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Range: 400 feet
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Shutter: 45° opening
Subject: EXPLORER III, initial flight stage, Cape Canaveral, Fla.
Date: March 26, 1958

That one "first take" *has* to be right for missile tracking . . . because there can't be any second trys or retakes!

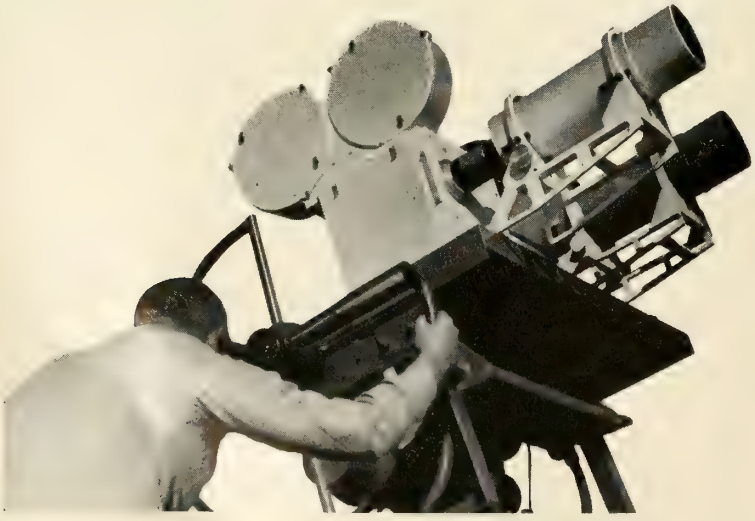
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Moscow briefs

• **A Soviet general** declares that "apparently the mastery of the process of guided thermonuclear reaction will bring us closest to the solution of the problem of the most economical (as regards weight) source of energy" for future space flights.

Maj. Gen. T. M. Melkumov, writing in VESTNIK VOZDUSHNOGO FLOTA, the monthly journal of the Soviet Air Force, is a doctor of the technical sciences and a professor of astronautics.

He also mentions the suggestion that trajectories of future interplanetary flights should be studied with special attention to the problem of "a minimum expenditure of energy for such flights."

He discusses the orbit of Mars, and dwells on the problem of changing successfully from the Earth's orbit to the orbit of Mars. He said this is a most vital point in establishing the flight's trajectory to Mars, particularly as pertaining to a minimum energy expenditure for such a space flight.

• **Level lunar areas** possibly exist, declares Prof. N. Barabashov, the well-known Soviet astrophysicist and chairman of the Planetary Committee of the Astronomic Council of the Soviet Academy of Sciences.

The latest study of the moon's surface by Soviet savants demonstrates that a considerable part of the lunar landscape is covered with a layer of vulcanic ashes and the products of the melting of the moon's ores. This is the result of the meteorite "showers" so frequently falling on the moon. As they fall, the meteorites become red-hot and melt, simultaneously causing the outer layer of the ores to melt.

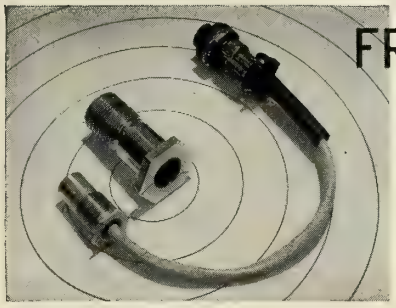
Certain parts of the moon's surface are apparently covered with large lumps of ores split open under the impact of the sharp changes in the moon's temperatures, from 120 Celsius degrees of heat in daytime to 200 Celsius degrees of cold at night.

Prof. Barabashov's statement was made in connection with a special session on the physical conditions of the moon and other celestial bodies, held recently in the Soviet Ukraine by the Academy's Astronomic Council. Astronomers, astrophysicists, and astrobotanists from all over the Soviet Union were in attendance.

• **"Sputniks and Chemistry,"** an article in SOVETSKAYA AVIATSIA, quotes Prof. I. P. Losev as saying that the latest Soviet chemical research played an important role in the successful launching of the three *Sputniks*.

Prof. Losev, who is doctor of the

do you have these missile power problems?



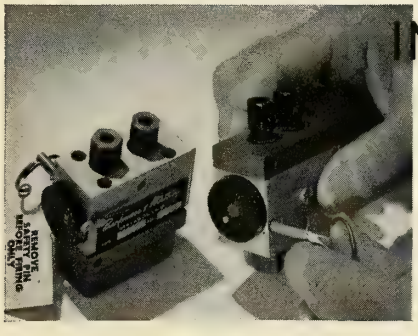
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chemical sciences and president of the Mendeleyev Chemical Society, declares that the *Sputniks* are well guarded from meteorite blows due to "Soviet-made plastics which are as strong as military tank armor, yet weigh lighter than wood."

He adds that the rocket carrying *Sputnik* III also owed its triumph to Soviet chemistry. "The rocket's heart—the engine—works at temperatures that can be endured only by special heat-resisting alloys and metal-ceramics. These alloys have been evolved by our science of chemistry."

Dr. Losev concludes by praising Russian chemists for the rocket's fuel, "which requires special care, and which, too, has been produced by the toil of our chemists."

• **From Sputniks to space flight:** "Our *Sputniks* prove the feasibility of interplanetary journeys," declared Prof. V. Fedynsky at a Moscow meeting of the Society for Dissemination of Political and Scientific Knowledge. Moscow TRUD reports that the professor's speech "was met with great interest."

• **"In Sputnik III,** a man can find enough place for himself, but it is still too early to speak of launching a *Sputnik* with a man in it," says Academician Leonid Sedov.

He points out that the main difficulty of sending a man up in a *Sputnik* is not in the "danger of biological character," but in the problem of re-entry. In the same statement, Sedov predicts that flight to Mars will become an actuality "within the next 20 years."

• **"Why must one fly into Cosmos?"** This is a headline in KOMSOMOLSKAYA PRAVDA, citing a letter from a Soviet reader who does not understand why all the fuss is made about the conquest of outer space.

"What is the pressing need for all those expenditures of money and materials and perhaps even of human lives for the sake of such conquests?" he asks. He goes on to say that he can understand the self-sacrificing heroism of physicians who experiment new vaccines on themselves; also the military courage of Soviet officers and soldiers; but "the meaning of conquering interplanetary space is incomprehensible to me."

The editor of KOMSOMOLSKAYA PRAVDA was shocked. He asked Prof. V. Dobronravov, an outstanding Soviet astrophysicist, to explain the reasons for man's wish to conquer outer space. The scientist answered in a lengthy article citing a number of valid reasons.

• **To encourage and satisfy the** popular Soviet interest in *Sputniks* and planets, ten "people's observatories" are being planned and built by Moscow municipal and regional authorities in parks and other public places.

Four of these observatories will be opened in July, and the rest will be opened later. Each observatory, built of brick in a cylindrical form, will be one-and-a-half stories high. Telescopes, available for amateur's use, have already been received from East Germany, where they were manufactured especially for this purpose. Not only observation, but also the photography of planets, will be available to the amateur Muscovite.

• **Nearly 900 non-Soviet astronomers** are expected in Moscow at the 10th International Astronomic Congress in August. Two symposiums are scheduled; one on the problem of the Earth's rotation, the other on the spectral problem and the question of evolution of stars.



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Results of the study of the sun's flares; the problem of the formation of chemical elements in stars; and astronomic observations with the aid of satellites, balloons, and rockets will also be discussed.

• **"Today solar batteries** on *Sputnik* III work together with silver-zinc accumulators," writes D. Bilenkin in KOMSOMOLSKAYA PRAVDA. "But on some future *Sputnik* solar batteries will be the only source."

• **Col. B. Aleksandrov writes** in his article "The Military Air Force of the U.S. in Europe", published in SOVETSKAYA AVIATSIA: "Striving to achieve a maximum strengthening of air grouping in Europe, the U.S. military authorities have moved three groups of TM-61 *Matador* guided plane-missiles into W. Germany. The launching sites of these plane-missiles, which have a range of nearly 1,000 kilometers, are placed in immediate proximity to the frontiers of socialist countries."

• **In order not to "upset" West German** public opinion, the Bonn government has sent the "guided rocket *Matador*" to the deserts of Libya in North Africa, instead of shipping them from the U.S. to W. Germany.

German soldiers will be trained to handle the *Matador* on North African sands. This "revelation" is made in the Moscow IZVESTIA, which in a special article, protests against the American, W. German, and French action in "turning Africa into an atomic and rocket launching site."

The Soviet newspaper charges that the Bonn government caused the *Matadors* to be sent to North Africa instead of W. Germany "on advice from Washington."

• **A large model of Sputnik III,** exhibited in the pavilion of the Academy of Sciences at the Industrial Exposition in Moscow, has attracted general attention.

• **In the anti-religious campaign** currently being stepped-up by the Soviet government, the Communist party's official organ PARTIYNAYA ZHIZN recommends to its propagandists of atheism that they use the successful launching of the three *Sputniks* as proof enough that "there is no God."

• **Mystic believers** in Western Europe have already chosen a special patron saint for interplanetary trips of the future.

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15 OPERATIONS

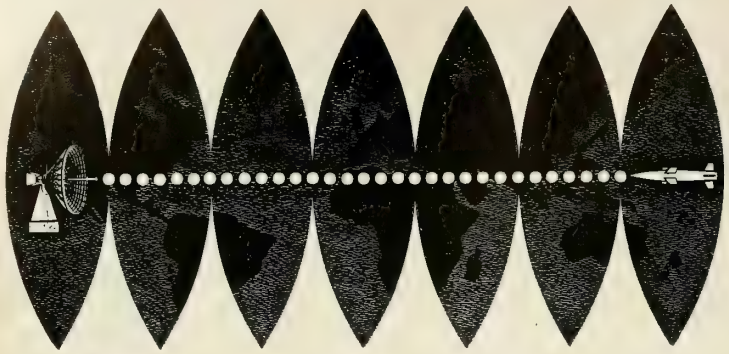
1. Cut off rod
2. Centerless ground
3. Heat treat
4. 100% inspection—material and roundness
5. Center hole drilled
6. One end faced and chamfered
7. Bored to finish dimension
8. Other end is faced
9. Shoulders turned
10. Degreased and inspected for dimensions
11. Roll threaded to a class 3 fit
12. Faced to final length
13. Slot ground
14. Deburred
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. . . Moscow briefs

in KOMSOMOLSKAYA PRAVDA, the saint is "Joseph Cupertino, canonized in 1767. He was a Franciscan monk who was reputed to possess the miraculous faculty of flying from the church doors to the altar and back."

• **Nearly 400 projects** of an obelisk to commemorate *Sputnik* I have been submitted in the contest sponsored by the Soviet government. Cash prizes are given for the best presentations. Not only sculptors, but engineers and architects are among the contestants.

More than 360 of the submitted models are now being shown in the Central Exhibition Hall in Moscow. The winning monument will be erected in the Lenin Hills of Moscow, near the skyscraper building of the University of Moscow.

• **A monument to Konstantin Tsiolkovsky,** the Soviet rocket pioneer, was recently unveiled in Kaluga, central Russia—for many years the residence and research site of the famous Russian astrophysicist.

A silvery rocket model, 19 meters high, is the background for Tsiolkovsky's bronze figure. The granite pedestal bears the inscription, "K. E. Tsiolkovsky. 1857-1935," and the following quotation from his writings:

"Mankind will not remain on Earth forever, but in its quest of light and space will at first timidly penetrate beyond the confines of the atmosphere, and later will conquer for itself all of the space near the sun."

• **The recent decrease** in the output of higher degrees of Soviet learning alarms the Moscow ministry of higher education.

The Ministry published figures which show that, whereas in 1955 some 11,800 diplomas of the candidate of sciences were issued in the Soviet Union; in 1956 only 7,800 such diplomas were earned; and in 1957 the number was catastrophically low—a mere 3,500.

Of the 240,000 Soviet scientists, one-half are on the teaching staffs of Russia's universities and institutes. Of this one-half, only a mere 43% have their learned degrees of doctors and candidates of the sciences—an inexcusably small ratio in the opinion of Soviet leaders.

• **U.S. devices of "long-range radars"** are described in a recent issue of KRASNAYA ZVEZDA (The Red Star), the central organ of the Soviet armed forces, on the basis of material appearing in m/r. Our magazine is quoted

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in the Moscow publication explicitly by name. An illustration, accompanying the Soviet article, is taken from our pages.

• **"We are not inclined to deprecate** the scientific genius of the American people," G. Rassadin writes in SOVETSKAYA AVIATSIA. "It isn't such a misfortune for them that they lag in satellite launching." But, the Moscow writer goes on, those "aggressors" in the Pentagon shouldn't try to create weapons aimed at the shooting down of Russia's *Sputniks*.

Nor should the Pentagon dream about "the establishment of American military bases on the Moon," which, as everyone knows, is "a peaceful and lyrical celestial body." Comrade Rassadin also recommends that "the liquidation of American military bases on other peoples' territories of the Earth" should have been the best and "most realistic reaction to the orbiting of *Sputnik* III."

• **"A space ship at any time,"** announce two Soviet scientists of aeronautics and astronautics in IZVESTIA. The pair are A. Ilyushin and V. Lensky, who declare that the new Soviet rocket designs and fuels will soon allow Russia to launch cosmic ships.

They write: "Our rocketry is capable at any time of overcoming the second cosmic barrier by adding to the speed of the original rocket, which was 18,000 miles an hour, one more stage which would produce a speed of over 25,000 miles an hour."

• **Rockets haven't displaced** conventional aircraft as a weapon. So writes Colonel A. Lapenin in SOVETSKAYA AVIATSIA, stating: "The logical process of the qualitative development of modern means of the air attack, particularly of ICBMs and IRBMs, does not at all mean that aviation has outlived its usefulness, and that in the very near future it will be completely replaced by rockets."

He points out that the arming of jet planes, both bombers and fighters, with air-to-ground and air-to-air missiles, also with atomic- and hydrogen-warhead bombs, only strengthens the role of military aviation rather than displace it. "Piloted planes will be needed in modern war," Col. Lapenin maintains, for in certain tasks in the warfare of today and tomorrow "reason-directed actions of a pilot" will be necessary.

• **A special military planetarium** has recently been opened in Moscow, introducing Soviet officers and soldiers to the space age. The planetarium is established at the Frunze Central House of the Soviet Army, with the aid of telescopes and other equipment.

Titles of lectures delivered to Red troop detachments brought to the planetarium are: "Flights into Outer Space," "About the *Sputniks*," "The Modern Concept of the Universe," and "What is Happening on the Sun?" A tower for visual observation of satellites is being erected next to the planetarium.

• **Soviet writers can imagine** future flights to Venus with an abundance of detail on the construction and performance of the Red interplanetary ship making the flight. They can visualize "cosmic landscapes" en-route to and from Venus. They can graphically describe the climate, flora, and fauna of Venus.

But they cannot create stories of the lives—of the day-to-day doings and characteristics—of the Communist astronauts of the future. There is hardly a detail in the writings of present-day Soviet science-fictioneers pertaining to the structure of the interplanetary Communist society of the future. Such is the latest charge advanced by the Moscow government against its own



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ACCURACY TO THE DEGREE "A"



New Ideal-Aerosmith Azimuth, Rock and Tilt Test Table for Missile Components Being Used in Connection With the Bomarc Program.

- For accurate pre-testing of missile and aircraft components.
- Ground Instrument simulates attitudes of flight.
- Reliable; easy to operate; safe in operation.
- Rock and Tilt motion to a 15-degree included angle.
- Azimuth motion to 15-degree included angle, plus or minus one degree.
- Pre-set stops for quick accurate leveling.
- Microswitch indication of position.
- Duty cycle is continuous.
- Modular design permits installation or replacement of parts with solderless connections.
- Can be adapted to remote control.

THE NEW IDEAL-AEROSMITH AZIMUTH, ROCK AND TILT TEST TABLE CAN BE USEFUL IN EVERY KIND OF MISSILE PROGRAM!

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STANDARD CASES: MOLDED FIBREGLASS CASES — 4 Sizes Available from Stock

Skydyne Inc.
PORT JERVIS, NEW YORK

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. . . Moscow briefs

science-fiction writers.

The complaint was voiced by Khrushchev's officials at the All-Russian Conference on Adventure and Fantastic Scientific Literature. No hint of Communism can be found in tales written by science writers, laments Vladimir Dmitrievsky in IZVESTIA.

"Apparently, the time of action is Communism," he notes about the modern Soviet tales of the future. "For only a Communist society, finally uniting all mankind, will be capable of achieving those things of which these writers tell us. Well, then, do tell us about the future of our Earth, friends, do tell us about Communism! . . . Otherwise, the writer of fantasy will not be able to crawl out of his shell of scientific and technical hypotheses, will not fling apart the doors of the future before the reader."

Could it be that Soviet writers cannot and will not write of this interplanetary Communism of the future because they believe in interplanetary flights, but do not believe in Communism? A heretical thought, comrades, but most likely a true one nevertheless.

• **How strong is the Soviet Academy?** The latest statistics of the Soviet Academy of Sciences, released by the Moscow government, show that the top body of Russian learning has a network of 75 major scientific-research Institutes, not counting a tremendous number of lesser Institutes within the Academy's 12 "filials."

In addition to the central Academy in Moscow, provincial capitals of the Soviet Union have 13 Academies of Sciences of their own. There are also many special, separate Academies for various industries. The central Academy in Moscow has 167 full-fledged academicians and 361 corresponding members (a lesser category).

• **"To predict today the future of astronautics** is a dangerous thing," Professor Anatoly Blagonravov said to the young people of the Soviet Union on the occasion of the recent Youth Day in his country. "The pace of space conquest is so fast, that, tomorrow, the boldest prognosis may become a mere commentary on the events of yesterday."

Still, the Soviet astrophysicist was "certain that some of you will have the luck of walking on the edges of lunar craters with hammers of geological exploration in your hands; and of compiling the map of the continents of Venus; also of describing the flora and fauna of Mars."

ENGINEER OPPORTUNITIES AT RAYTHEON



ARMY'S HAWK MISSILE is launched from mobile platform by fast-moving land forces. Raytheon engineers working on prime contract developed the design that makes possible missile's extremely low-altitude capabilities.

Where is your future in Missile Engineering?

It's your move. Your experience as a specialist in aeronautical design work qualifies you for good positions with a number of capable organizations. But somewhere is that special situation that will lead to the rewarding future you want.

Before you make your next move, you'll want to take a long careful look at the leading companies in missiles and where they are heading. Your company list will include Raytheon —now prime contractor for the Army Hawk and Navy Sparrow III, with *continually expanding* development programs that need the talents of capable men in:

STRUCTURES: Stress analysis • Structural design • Dynamic analysis • Static testing • Weight analysis

AERODYNAMICS (Missile): Stability and Control • Air loads Performance

WIND TUNNEL TESTING • AERODYNAMIC HEATING
ROCKET ENGINEERING (Solid)

For interview in Bedford, Mass., please write, wire, or phone collect to CRestview 4-7100. Ask for R. W. McCarthy.

RAYTHEON MANUFACTURING COMPANY

RAYTHEON — *MISSILE SYSTEMS DIVISION*

Excellence in Electronics — *BEDFORD, MASS.*

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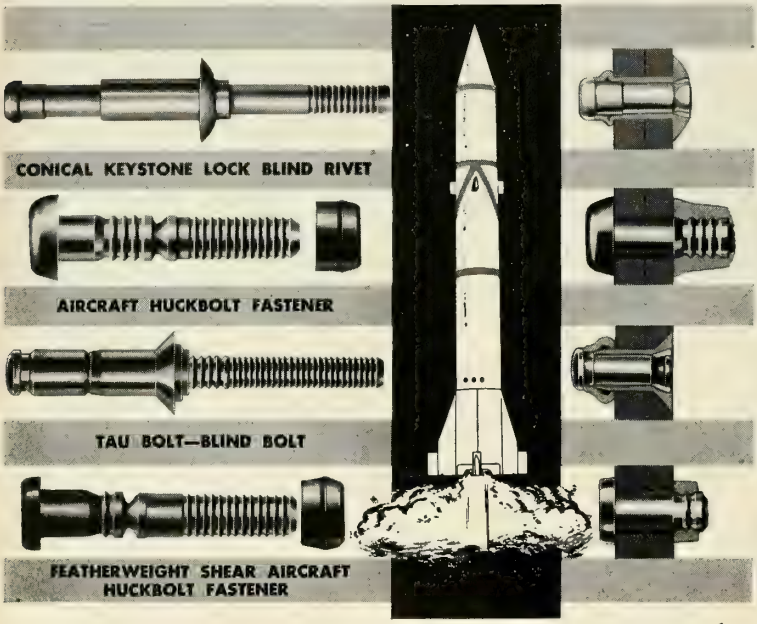
Sidereal Rate Turntable Measures Gyroscopic Drift

A sidereal rate test turntable to measure error or drift of gyroscopic and inertial equipment is available from J. W. Fecter Inc., subsidiary of American Optical Co.

The unit, claimed by the company to be "the most accurate in production today," is a positively driven, equatorially mounted platform which rotates at exact pre-set rates equal to the earth's rotation or at multiples of the earth's rate in either direction. With the effect of the earth's rotation effectively nullified, the equipmnt under test is isolated in inertial space. Its performance under known drift rates can be evaluated. With a 360 degree rotational cycle, position to an accuracy of plus or minus 3 seconds of arc is maintained.

The drive system is housed in the table's pedestal and incorporates a hysteresis synchronous motor couple with precision reduction gears.

Circle No. 248 on Subscriber Service Card.



ENGINEERED FOR *out-of-this-world* PERFORMANCE !

Huck pioneered the development of high strength—low weight fasteners for the aircraft industry. Huck's vigorous research and development program keeps these fasteners abreast of today's fast changing requirements.

Huck produces a complete line of aircraft fasteners in aluminum or steel for blind or two side application. There is a style to meet any aircraft requirement . . . high shear or tensile strength, sealing, hole filling, pull together or vibration proof . . . available in flush or protruding heads and with positive mechanical lock.

HUCKBOLT FASTENERS are available in all desirable "exotic metals" for unusual strength at elevated temperatures. Samples available for engineering evaluation.

Your inquiries are invited.

2480 BELLEVUE AVENUE • DETROIT 7, MICHIGAN • Phone WA. 1-6207 **HUCK** *MANUFACTURING COMPANY*

Circle No. 90 on Subscriber Service Card.

Overload Clutches Protect Against Damage

Mechanical overload clutches designed to protect assembly machinery against damage have been brought out in a new line of "Safe Torque" clutches by Scully-Jones and Co., Chicago.

Two standard ratings of precise torque control clutches are currently available: to 84 in. lb., and 48 to 120 in. lb. Other models have been developed up to 800 lb. ft.

Two general lines of clutches are included in the Scully-Jones line: a one-shot type and a continuous overriding type. Torque setting of the clutches can be sealed against unauthorized tampering, if desired. One-shot clutches may be re-engaged in several ways—by reversing the rotation of the drive shaft, by axial movement, or other means. Continuous overriding clutches are used on slow-running applications such as hand-tightening of fasteners.

Circle No. 249 on Subscriber Service Card.

Shaft-Angle Encoder Has Built-in Alignment

A new Dychroverter which can meet the structural and operational requirements of 13-digit shaft-angle encoding contains a built-in alignment cell for establishing optical-mechanical concentricity precise to 110 parts per million.

Designed and built by Dychro Corp., accuracy of shaft-angle indication can be held to better than xx ±2.5 minutes of arc. At 366 rpm, the probability of a 1-bit error, representing only a ±1.3 minute maximum angular error, is 0.75. Readout is possible up to a maximum reading rate of one hundred complete digital words per second. Dychroverter can encode the angular position of high-speed rotating shafts without use of brushes or moving contacts.

The instruments are useful as the feedback element in digital shaft positioning servomechanisms, to couple rotating analog devices into digital computers and for converting two-speed analog shaft data into a single, linear, digital word for data processing.

Circle No. 250 on Subscriber Service Card.

Practical Inductance Limits Available

Magnetics Inc. has introduced guaranteed practical inductance limits for regular and temperature stabilized permalloy powder cores.

According to the company, the temperature-stabilized permalloy powder

cores, which produce frequency stability, eliminate difficult compensation problems.

The new inductance limits are guaranteed for all permalloy cores, whether stabilized or not, and are available in 7 sizes. The "D" range powder cores have a total inductance change of less than .2% between 30°F and 130°F.

Circle No. 251 on Subscriber Service Card.

Atlanta, Inc. Offers New Range Towers

A new series of model range towers for supporting and positioning antennas, reflectors and scale model airframes is available from Atlanta, Inc.

Built entirely of low dielectric constant materials above the base unit, reflectivity or radiation pattern measurements can be made under simulated free space conditions.

The company listed other features as variable speed drive and dual synchro position information for both axes, optional height of 8 and 16 feet by use of an 8-foot extension section and a load capacity of 200 pounds.

Circle No. 252 on Subscriber Service Card.

Servo Motor Gear Heads Have Close Tolerances

A new line of servo motor gear heads, said to be adaptable to any make of motor, has been announced by the Instrument Division of Thomas A. Edison Industries.

The announcement said that the heads are available in any ratio between 1%, and that the gears have a backlash of only 30 min. maximum, measured at the output shaft with maximum running torque applied as a reversing load. Closer tolerances are said to be possible, on special order.

The great precision is said to be a result of spacing gear clusters between separate gear plates, and the use of bronze gears and stainless steel pinions splined to their shafts for added strength.

Circle No. 241 on Subscriber Service Card.

Bobbinless Resistors For Missile Applications

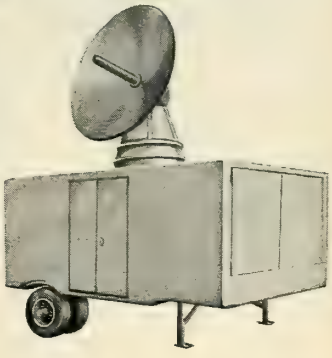
Packaged in two case styles—R-2 and R-5—a line of bobbinless precision wire-wound resistors is now available from General Transistor Co. of Jamaica, New York City.

The units are claimed to be ideally suited for printed circuit boards, and subminiature assemblies for airborne and missile applications.

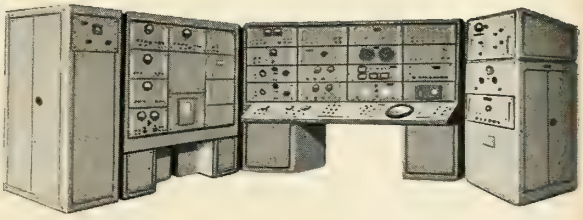
According to the company, principal

THE AN MPS-26 RADAR (C-BAND)
SEARCH ACQUISITION AND PRECISION TRACKING RADAR SYSTEM - - - - - - by CANOGA
NOW TO BE USED FOR
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BY THE NAVY, BUREAU OF AERONAUTICS

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High power capability for extreme range performance.

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to probe high-altitude, high-temperature frontiers



. . . CEC's 5-122 Recording Oscillograph

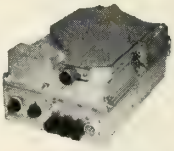
permanently records 26 channels of data simultaneously (plus 2 reference traces) on film or paper

CEC'S 5-122 IS BUILT TO TAKE IT—to surpass the endurance of ordinary instrumentation. Compare this combination of environmental *operating* specifications with any oscillograph made: Temperature range from −65° to +250°F at altitudes to 120,000 feet . . . Will withstand a steady acceleration of 15 G's along any of its three major axes without interruption or deterioration of its performance . . . Operates in salt-sea and dust-laden atmospheres and in a relative humidity up to 100% at +122°F. . . Explosion-proof certification. . . Built-in vibration isolators provide firm protective support and eliminate the need for external shockmounts.

CRASH-RESISTANT MAGAZINE. The all-important record of test results is always secure in the 5-122's record magazine. This crash-resistant unit is engineered to withstand the same abuses as the oscillograph plus a shock of 200 G's for 4½ milliseconds.

NOTHING SACRIFICED FOR ENVIRONMENTAL SPECIFICATIONS — Standard features of the 5-122 include a writing speed of more than 12,000 ips . . . jump-speed selector . . . flash timing . . . 12 record speeds from 0.047 to 96 ips . . . automatic record identification . . . and provision for synchronous operation with an over-all data acquisition system. The 5-122 weighs only 80 lbs. fully loaded and is 11″ wide, 8″ high, 18½″ long.

For complete details, contact your nearest CEC sales and service office or write for Bulletin CEC 1585-X11.



MASTER TIMING UNIT supplies timing pulses to the 5-122. Can control up to 10 oscillographs and may be remotely located.



CONTROL UNIT contains all controls for operation of oscillograph. Is also ideal for remote operation.



HIGH-TEMPERATURE GALVANOMETERS — CEC High-Temperature Galvanometers guarantee high sensitivity and accuracy in ambient temperatures to 250°F for extended periods. Fluid and magnetically damped types cover frequencies from 0 to 3000 cps. Write for Bulletin CEC 1528-X17.

Consolidated Electrodynamics

300 North Sierra Madre Villa, Pasadena, California

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features of the instruments include: welded case construction to insure hermetic seal; welded terminations to eliminate noise; bobbinless construction which eliminates strain and stress on wire under extreme environmental conditions.

Circle No. 242 on Subscriber Service Card.

Holding Fixture Designed For High-Speed Production

A dual-chucking, cylinder-operated holding fixture, said to be designed for use on high-output production operations, is now available from S-P Manufacturing Corp.

The fixture is designed to be used individually or in groups on a rotating work table, to provide simultaneous chucking of two identical parts. The fixture provides clamping jaws set at a 45 deg. angle so that both horizontal and vertical machining can be done without rechucking.

Circle No. 243 on Subscriber Servce Card.

Primary Battery Operates at —100° for Cold Work

Named the Yardley Arctic, a primary battery that is said to operate at –100°F has been developed by Yardney Electric Corp.

According to company announcements, the product is the first unit that can supply appreciable currents at temperatures below –65°F. The cell, which is non-aqueous, employs calcium for the negative plate, silver chloride for the positive plate, and an electrolyte with acetonitrile solvent. The unit is hermetically sealed and is expected to have an indefinite shelf life.

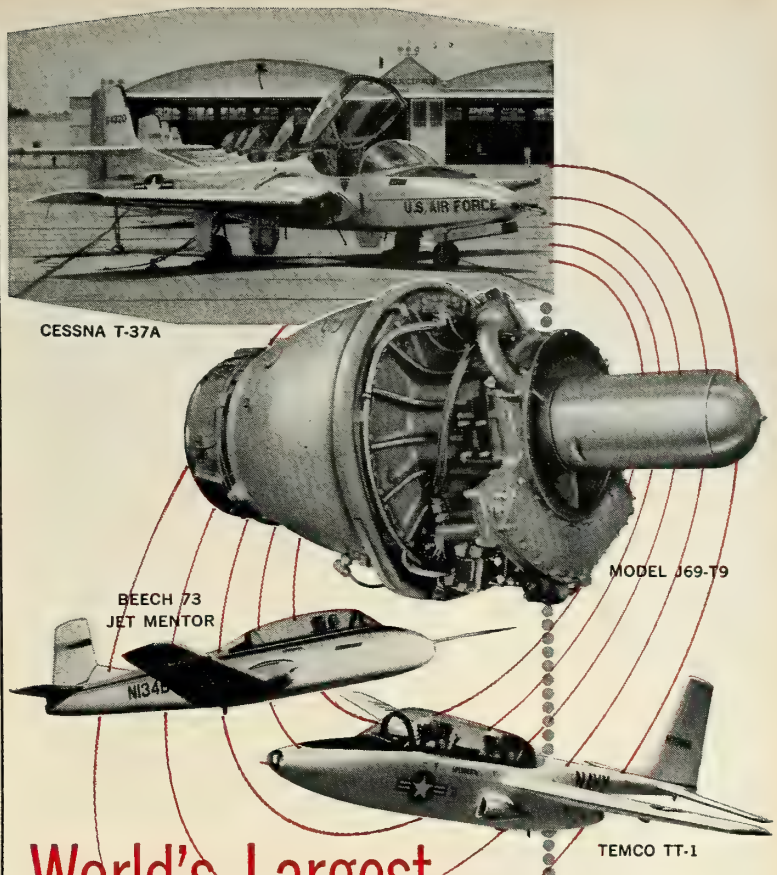
Circle No. 244 on Subscriber Service Card.

High-Performance Torquer for Stabilized Platforms

A new high-performance Torquer, Model ARTQ-1, has been developed by Aeroflex Corp. to actuate large stabilized platforms mounting heavy aerial cameras, infra-red devices and radar antennas.

The Company says that a new design and new manufacturing techniques allow fabrication at low cost, while at the same time reducing the weight and size of the torquer. It is also claimed that the design makes possible extremely smooth motion and eliminates radio noise, sparking, wear and explosion hazards.

The machine is said to be capable of high-altitude continuous performance in ambient temperatures of 130°



World's Largest Manufacturer of Small Gas Turbines

As the pioneer American builder of small gas turbines, Continental Aviation and Engineering Corporation occupies a unique position in this relatively new field of power. Not only is it the largest producer of engines of this type and size; it is also the most thoroughly qualified by experience, and the most completely equipped. Those having present or prospective need for gas turbine power—for applications on land, at sea, or in the air—are invited to lay their problems before C. A. E. engineers.


MODEL J69-T-19A

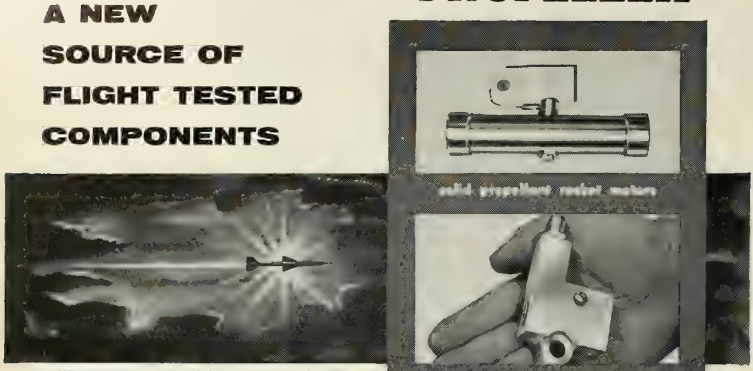

MODEL 141
AIR COMPRESSOR

CONTINENTAL AVIATION & ENGINEERING CORPORATION
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LIQUID OXYGEN AND NITROGEN TRANSPORT UNITS



Hofman 3000 Gallon Trailer

Built to A.S.M.E. and I.C.C. specifications in sizes from 500 to 3500 gallons. Efficient performance is shown in this Hofman powder in vacuum insulated equipment. Standard features include: bottom fill and discharge line, top fill line, liquid level gauge, vacuum valve and filter, thermocouple vacuum gauge, pressure gauge, A.S.M.E. code stamped inner vessels, quick pressure build-up system, extended stem valves on liquid lines, ending with Hofman quick couplings.



Hofman 500 Gallon Truck

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Dept. D, 5 Evans Terminal, Hillside, N. J.

WESTERN AGENTS | BLAIR-MARTIN CO., INC. 1010 Fair Oaks, So. Pasadena, California (Calif., Ariz., N. M.) THE DARLING CO., P. O. Box 277, Wheatridge, Colorado (Colorado, Wyoming, Utah, Nevada)

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. . . new products

centigrade, and develops torques up to 15-in. lb. at a torquer weight of 6 lb. for the camera application.

Circle No. 245 on Subscriber Service Card.

In-Line Flow Regulator Pressure Compensated

A new in-line pressure-compensated adjustable flow regulator is now available from Fluid Power Accessories.

Changes in flow rate are accomplished by rotation of the valve sleeve. According to the company's announcement, calibrations of the sleeve facilitate repeat flow settings without tedious adjustments. A built-in check valve provides for free flow in the non-compensated direction. The valves are available in one-quarter, three-eighths and one-half inch pipe sizes, for flow rates to 5, 10 and 18 gpm. Maximum operating pressure is 3,000 psi.

Circle No. 246 on Subscriber Service Card.

Low Voltage "Strings" For Precision Instruments

A new line of Zener reference "strings" designed specifically for an extremely low amount of voltage change over a wide temperature range has been introduced by the Semiconductor Division, Hoffman Electronics Corp., Evanston, Illinois.

The "strings" were designed for applications where voltage output and temperature coefficient requirements are not compatible with the performance of a single Zener diode, such as in the precision instrumentation field.

Typical applications include semi-precise regulator circuits, where temperature stability is of prime consideration and line or load changes are not wide or have been reduced by pre-regulation; as the input stage in precision circuitry employing lower temperature coefficient reference elements, and as the reference element for feedback power supplies where higher voltage than a single 1N429 is required from the system gain and bias considerations in the external circuitry.

Circle No. 247 on Subscriber Service Card.

Compact Electronic Timers Designed for Military Use

The A. W. Haydon Co. of Waterbury, Conn. manufacturers of standard and custom designed electrical and electro-mechanical timing devices, has announced a new line of Electronic Time Delay Relays.

Some of the main features which these timers will offer, that cannot readily be supplied in electro-mechanical

timing devices, will be high temperature operation, high vibration, light weight and very short time delays.

A transistorized R.C. time constant network is used to establish the time delay and eliminate all moving parts except the load switching relay. Designed primarily for military applications these compact units offer high reliability under extreme conditions of temperature, vibration and shock.

Two series are currently offered with time delays ranging from 50 milliseconds to 60 seconds. Operating voltage for either type will be 18 to 30 Volts D.C., although operation on A.C. voltages can be offered.

Circle No. 253 on Subscriber Service Card.

Ultra-High Temperature Absorber Available

Eccosorb HT, developed by Emerson and Cumings, Inc., is a series of broadband microwave absorbers which are useful from −70°F. to +1200°F. Because of high temperature capability, the absorber can be used where high power levels are involved. It finds particular application for lining metal housings used to cap radiating antennas. Exact power handling of Eccosorb HT is dependent upon the heat transfer situation. A typical value is 50 watts/square inch.

Eccosorb HT is supplied in the form of light weight unicellular foamed ceramic bricks. These bricks can be stacked on one another to produce a self-supporting wall, or they can be set into a housing with motar as in a masonry practice. Edges of bricks can be mitered to allow cylindrical structures. Being completely inorganic, Eccosorb HT will not burn.

Reflectivity of Eccosorb HT is low when measured under free space conditions. This assures a low VSWR in the antenna feed line when the absorber is used in a cap application.

Circle No. 254 on Subscriber Service Card.

Skiatron Offers Line of Plug-In Printed Circuits

A complete line of plug-in printed circuits in modular form, which fully meet all applicable JAN specifications, has been developed by Skiatron Electrons & Television Corp.

The various types bales available include: multi-vibrators, high speed binary and decimal electronic counters, stepping switches, operational amplifiers, storage devices, for both short and long-term applications; pulse-shaping circuits, timing and delay circuits, diode logic "AND," "OR," and "NOT" circuits

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SPACE SCIENCES
WEAPON SYSTEMS

Aeronutronic Systems, Inc., a subsidiary of Ford Motor Company, is expanding military and commercial programs in Glendale and at modern, new facilities overlooking the Pacific Ocean at Newport Beach, California. Outstanding career opportunities for qualified scientists and engineers who are U.S. citizens, and have B.S., M.S. or PhD degrees, are available in the following fields:

SPACE SCIENCES – Physics, astronomy, electrical or mechanical engineering – to perform research and development studies on fire control concepts for weapons systems, precision trans-lunar and interplanetary trajectories, and to evaluate guidance requirements.

WEAPON SYSTEMS – Mechanical, aeronautical, civil or chemical engineering – with experience in research and development of aerochemistry and propulsion, astronautics, missile design and analysis, and thermodynamics of high speed missiles.

Qualified applicants are invited to send resumes and inquiries to Mr. K. A. Dunn.

AERONUTRONIC SYSTEMS, INC.
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FREE 180 PAGE WELDING DATA BOOK

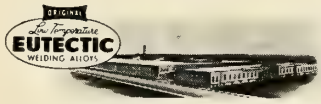


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CHOOSING THE RIGHT ROD FOR THE JOB • 150 DIFFERENT ALLOYS INDEXED AND THOROUGHLY EXPLAINED • TIPS FOR MACHINEABLE AND COLOR MATCHING DEPOSITS • RECOMMENDED AMPERAGES • TORCH SETTINGS AND ELECTRODE TECHNIQUES FULLY DIAGRAMMED • NEW WAYS TO CUT DOWN ON WELD METAL WASTE.

Also: money-saving suggestions on Overlays, Paste Alloys, Cutting, Preheating, Shims, Flux, Metalworking and an illustrated chapter on Controlling Heat Input... how to avoid warping, embrittlement and distortion.



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AIRCRAFT ARMAMENTS, INC.
Cockeysville, Maryland

AAINC. MODEL 2830
MISS-DISTANCE MEASURING SYSTEM
AN/USQ-11

– developed by Naval Ordnance Laboratory, Silver Spring, Maryland
– product-engineered and produced by Aircraft Armaments, Inc.

FOR TARGET DRONES



OUTSTANDING FEATURES: Meets MIL-E-5272A 5400B, 16400 -- provides data in 2 min. -- requires transponder in drone only -- measures salvo firings -- determines miss on multiple targets. Target equipment (less power supply) under 2 lbs. Accuracy confirmed by field tests.

TARGET TRANSPONDER

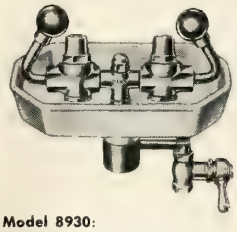
A SUBSIDIARY OF UNITED INDUSTRIAL CORP.

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Protect Eyes



with HAWS EMERGENCY EYE-WASH FOUNTAINS



Model 8930:
Basic eye-wash model; enameled iron bowl, chrome plated brass heads. HAWS also offers eye and face wash fountains and drench showers.

Chemicals, foreign particles, caustics – all mean DANGER to eyes! Instant relief is vital! HAWS Eye-Wash Fountains flood the eyes with controlled water streams – soothing, relieving until medical aid arrives. Fool-proof operation activates fountain instantly, possibly avoiding permanent injury. HAWS Emergency Facilities are also widely used for routine cleansing of eyes as a precautionary measure. Write today for illustrated literature on HAWS complete line of emergency facilities.

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. . . new products

gating circuits and transmission gates, relay and switching circuits, voltage regulators, pulse generators, clocks and gated oscillators, and analogue to digital conversion systems and vice versa.

Although each type of bale performs a single major function, most types include versatile circuits that provide for ANDing, O Ring, non-critical triggering, fast rise time, choice of inversion, and a wide variation of operating parameters.

Special features of the bales are printed wiring, conservatively rated components, plated-through and eyeletted holes tube heat sinks, right-angle connectors, and rigid board mounting frames.

Circle No. 255 on Subscriber Service Card.

Gate Valve Simplifies Propellant Handling

The handling of hydrogen peroxide in the high velocity propellant applications is made simpler and safer by a gate valve, according to Hamer Valves, Inc.

Environmental tests have been conducted on the valve, subjecting it to the various conditions encountered in the use of hydrogen peroxide.

It was found that in dealing with hydrogen peroxides, rapid decomposition, it was advisable to design the valve with the seal on one side only—and to place the seal in the wedge. Thus, by placing the seal on one side only, the possibility of dangerous pressure building up through decomposition in the valve chest is eliminated.

Placing the seal in the wedge simplifies construction and replacement, and eliminates objectionable cavities. In the event the seal ring wears out or fails, it may be quickly and easily replaced.

The renewal seal is made of Teflon, a material that is long-lasting and possessing strong sealing characteristics for hydrogen peroxide. The wedge itself is micro-finished, with its eating surfaces precision-machined to provide an exacting metal-to-metal fit. The seat is integral with the valve body. The bore of the body is machine finished to provide a clean, smooth fluid contacting surface.

A tiller-type handwheel, exclusive with Hamer, affords maximum leverage for opening or closing the valve. The chevron packing is long lasting and sure sealing, being designed to expand as pressure increases, to prevent escapage at the stem.

Circle No. 256 on Subscriber Service Card.

Beltrol

There is nothing like it in pressure switching



DESIGNED TO AIRCRAFT SPECIFICATIONS



PATENT APPLIED FOR

AND PRICED FOR COMMERCIAL APPLICATIONS



BUILT TO MISSILE SPECIFICATIONS

Pressure Range Setting 0 to 500 PSIG
Current Rating 10 amps ind. at 28 VDC
10 amps 115 VAC
Tested to MIL Spec. MIL-E-5272A and vibration to 50 G's
10 to 2000 cps.

Weight 7 ounces
Cubic Volume 6 cubic inches
Stability —65° to 325° F tolerance of plus or minus 5%

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Second Annual

GUIDED MISSILE ENCYCLOPEDIA

1958

An Exclusive Weapons Systems Roundup for Industry Compiled and Written by MISSILES & ROCKETS' Editors

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**Some of the specifications and performance figures given for the missiles and rockets in this encyclopedia have been calculated and have not necessarily been officially confirmed.*

U.S. AIR FORCE

Atlas 112
Bomarc 110
Falcon I 106
Falcon II 107
Genie 108
Goose 111
Mace 113
Matador 114
Rascal 109
Snark 115
Thor 116
Titan 117
Missiles of the future 118

U.S. ARMY

Corporal 122
Dart 123
Hawk I 119
Honest John 124
Jupiter 125
Lacrosse 126
Little John 127
Nike-Ajax 120
Nike-Hercules 121
Redstone 128
Sergeant 129
Missiles of the future 130

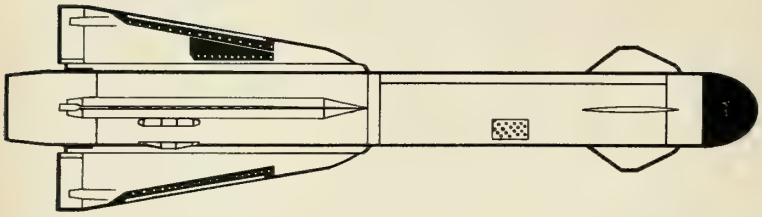
U.S. NAVY

Bullpup 134
Polaris 138
Rat 135
Regulus I 139
Regulus II 140
Sidewinder 131
Sparrow III 132
Talos 136
Terrier I & II 137
Zuni 133
Missiles of the future 141

U.S.S.R.

Air-to-air 142
Anti submarine 142
Surface-to-air 142, 143
Surface-to-surface 144-147
Underwater-to-air 148
Underwater-to-surface 148

FALCON I



Falcon GAR-1D is an operational Air Force air-to-air missile designed to be launched from an interceptor aircraft for destruction of enemy bombers.

Developed by Hughes Aircraft Co., the *Falcon* is part of a complete weapon system for the Northrop F-89 and the Convair F-102A and F-106A interceptors. Guidance is by radar impulse generated by the interceptor.

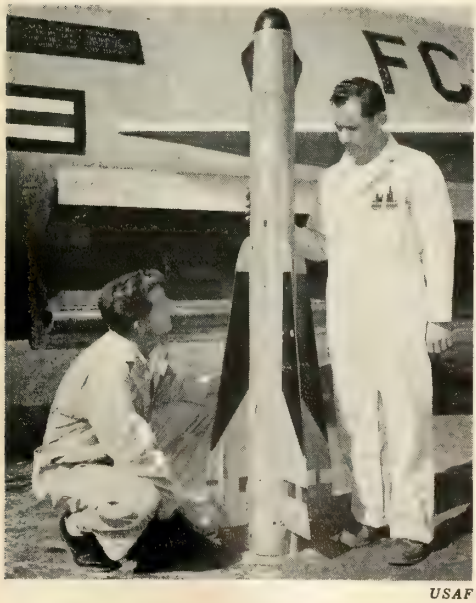
The *Falcon* need not be aimed precisely at the target, since the missile can sense the location of a selected target and seek it out. It can be launched on a climbing course from an interceptor that is far below the enemy bomber.

Latest model of this small lightweight missile has incorporated several aerodynamic improvements with greater altitude capability than the early GAR-1. Mainly, this involved changes in the steering control surfaces hinged to the trailing edge of the stabilizers. Main wings are fixed with movable canard control surfaces forward. The radar is housed in a blunt nose cone which fairs into a cylindrical fuselage.

Falcon is the smallest air-to-air guided missile in operational service, not excepting the *Sidewinder* and *Sparrow* group. It is slightly over six feet in length and weighs approximately 100 pounds. Range is about five miles with a maximum velocity of Mach 2. Propulsion power is supplied by a Thiokol solid propellant motor developing 6,000 pounds thrust.

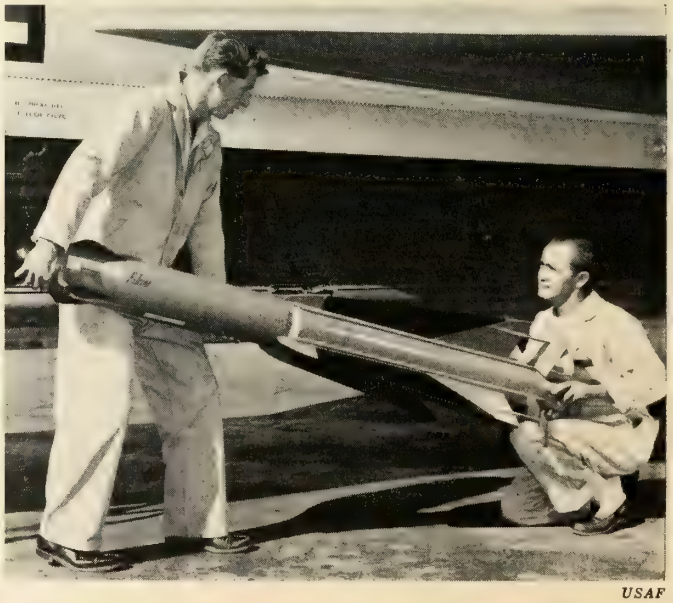
GAR-1D production costs are currently under $15,000 a unit, with a further drop expected.

DESIGNATION:	GAR-1D
PRIME CONTRACTOR:	Hughes
STATUS:	Production, service use
RANGE:	5 miles (approx.)
VELOCITY:	Mach 2+
FRAME	
Manufacturer:	Hughes
Length (Overall), ft:	6
Diameter (Body), ft:	0.5
Span, ft:	2
Weight (Gross), lb:	100
Material (Major):	Magnesium
GUIDANCE	
Manufacturer:	Hughes
Type:	Radar homing
POWER PLANT	
Manufacturer:	Thiokol
Propellants:	Solid
Type & Number:	Cast (1)
Thrust, lb:	6000
WARHEAD	
Type:	High explosive



USAF

GAR-ID has control improvements over GAR-I.



USAF

THE *FALCON* IS LIGHT enough (100 lbs.) to be handled by two men.

FALCON II

The addition of the *Falcon* GAR-2A to the Air Force arsenal of air-to-air weapons will probably mean mixed payloads on a single interceptor. A combination of radar and infra-red guided missiles on the same mission would greatly enhance the possibility of target interception.

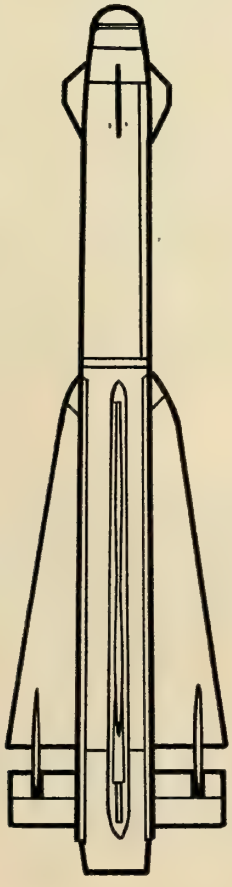
The configuration of the initial series of *Falcon* missiles has been altered slightly for the incorporation of the infra-red detection system. The IR detector is extremely sensitive, enabling the missile to "lock on" the target at greater ranges than was possible with the *Falcon* I-D.

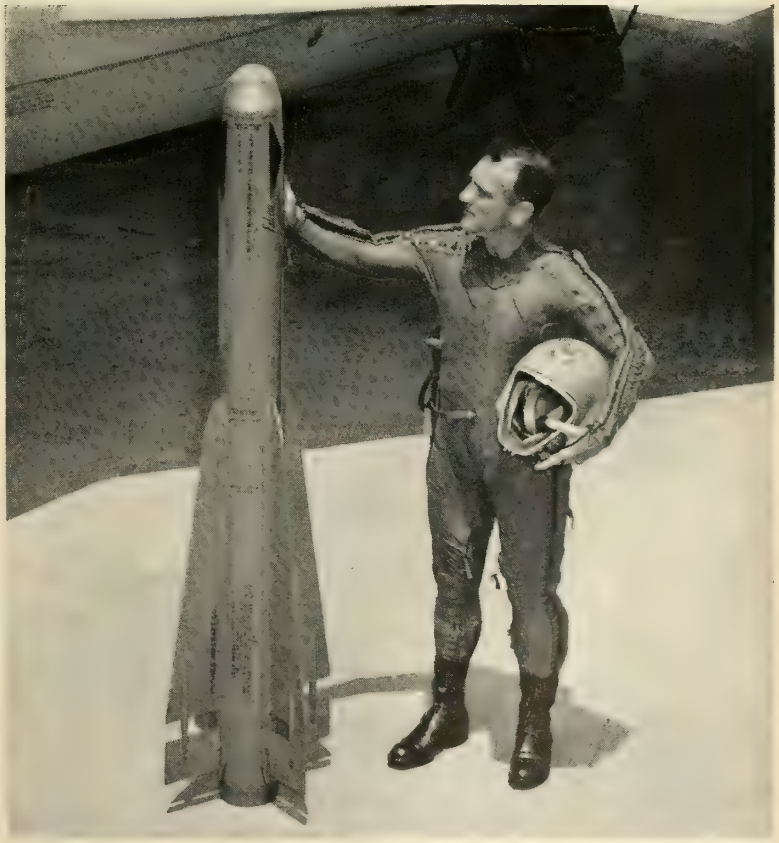
Test shots against target drones carrying flares has been highly successful. In many instances, the missile destroyed the flare without damaging the drone.

The missile's sensitivity makes it very undesirable in cloud formations. It is for this reason that mixed loads will be carried by most interceptor aircraft. The wide-look angle of its infra-red "eye" also permits it to be launched far to one side of the target, therefore making it unnecessary for an interceptor pilot to confine himself to a dangerous tail attack.

Dimensions and weight of the 2A are almost the same as the GAR-I. It can be fired singly or in salvo. As in the earlier model, the 2A is powered by a Thiokol solid propellant rocket, which accelerates it to approximately Mach 2.

DESIGNATION:	GAR-2A
PRIME CONTRACTOR:	Hughes
STATUS:	Production, service use
RANGE:	5 miles (approx.)
VELOCITY:	Mach 2+
FRAME	
Manufacturer:	Hughes
Length (Overall), ft:	6
Diameter (Body), ft:	0.5
Span, ft:	2
Weight (Gross), lb:	100
Material (Major):	Magnesium, aluminum
GUIDANCE	
Manufacturer:	Hughes
Type:	Infra-red homing
POWER PLANT	
Manufacturer:	Thiokol
Propellants:	Solid
Type & Number:	Cast (1)
Thrust, lb:	6,000
WARHEAD	
Type:	High explosive





USAF

THE PSEUDO-CANARD *Falcon* **GAR-2A is equipped with infra-red detection system.**

GENIE

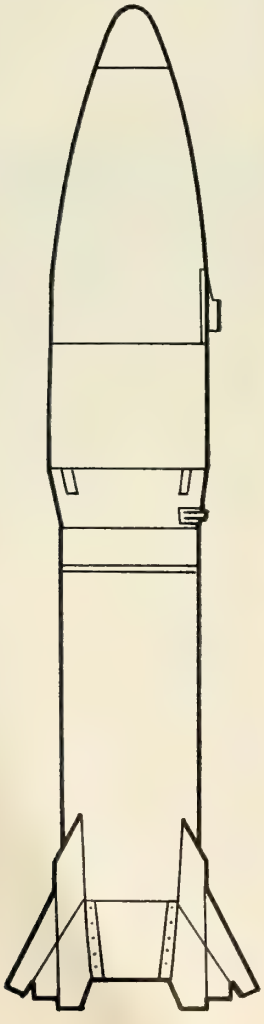
The *Genie* MB-I was the first air-to-air missile to be equipped with an atomic warhead. Since its inception, *Genie* has been tagged with a variety of names including *Ding-Dong, Bird Dog,* and *High-Card.*

Design studies for the *Genie* were started by Douglas Aircraft Co. in 1956, one year after the first atomic warhead packages for air-to-air missiles were tested to provide basic information on missile requirements.

First flight tests of the *Genie* were conducted in 1957 at AEC atomic firings. Carrier aircraft were Northrop F-89D's. Results of the tests were considered highly successful. The McDonnell F-101 Voodoo long range fighter is the latest aircraft to be equipped with these atomic missiles.

Current model of the *Genie* is powered by an Aerojet-General solid propellant rocket motor. Both liquid and solid replacements for the *Genie* are under development. First MB-Is were unguided, although a guided version has been designed and is under development.

DESIGNATION:	MB-1
PRIME CONTRACTOR:	Douglas
STATUS:	Production, service use
RANGE:	1.5 miles
FRAME	
Manufacturer:	Douglas
Length (Overall), ft:	8
Diameter (Body), ft:	1.25
Span, ft:	2
POWER PLANT	
Manufacturer:	Aerojet
Propellants:	Solid
Type & Number:	Cast (1)
WARHEAD	
Type:	Nuclear





Lower—McDonnell

AN ADVANCED MODEL of the *Genie* MB-1 is under development by Douglas.



Lower—McDonnell

McDONNELL F-101 Voodoo fighter in flight with two *Genies* externally mounted.

RASCAL

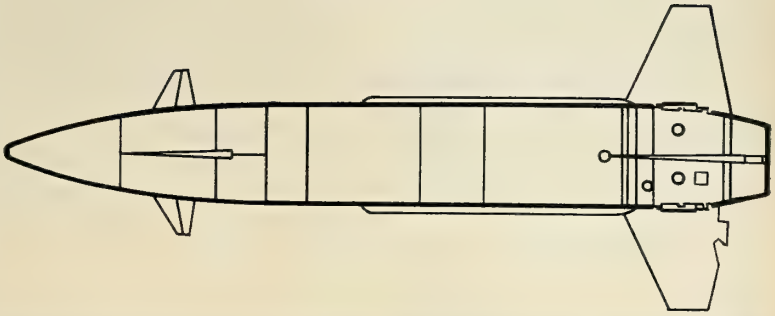
The *Rascal* GAM-63 is a liquid propellant rocket missile in development production by the Guided Missile Division of Bell Aircraft Corp. for the Air Force. An air-to-surface missile, nicknamed "Crew Saver," this weapon permits the delivery of nuclear warheads by piloted aircraft without endangering the crew to the hazards of local defense systems.

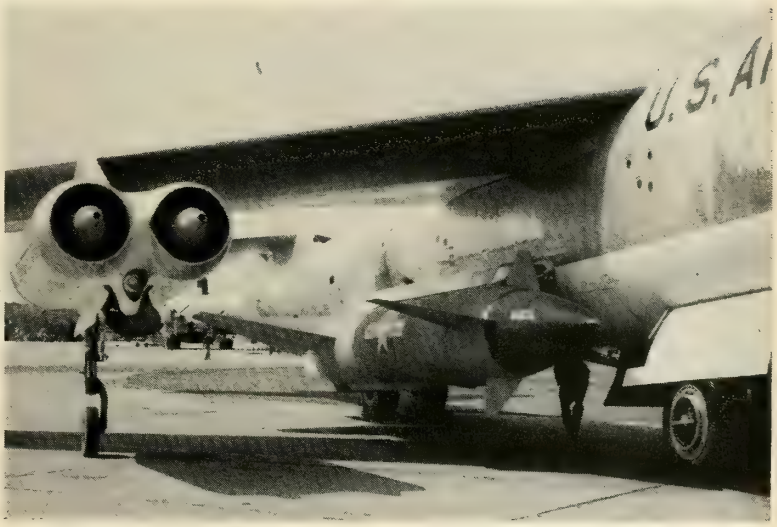
Stratojets, designated DB-47s, carry the *Rascal* on large pylons mounted on the right side of the fuselage under the wing. The missile is designed to be carried aloft by strategic bombers to be released miles from the target, allowing the crew to avoid defending interceptors and anti-aircraft missiles of the defended area.

The range of the *Rascal* is reported to be in excess of 100 miles. It utilizes a three-chambered liquid propellant rocket engine, developing a total thrust of 12,000 pounds. The missile achieves a velocity of approximately Mach 1.5 in the flight to the target.

Bell Aircraft, under Air Research and Development Command cognizance, has been responsible for the original design and development of the *Rascal* system.

DESIGNATION:	GAM-63
PRIME CONTRACTOR:	Bell
STATUS:	Production
RANGE:	100 miles max.
VELOCITY:	Mach 1.5 max.
FRAME	
Manufacturer:	Bell
Length (Overall), ft:	32
Diameter (Body), ft:	4
Span, ft:	14 (approx.)
Weight (Gross), lb:	13,000
Material (Major):	Aluminum
GUIDANCE	
Manufacturer:	Bell, RCA, Texas Instruments
Type:	Radar command
POWER PLANT	
Manufacturer:	Bell
Propellants:	Liquid oxygen & alcohol
Type & Number:	Liquid, Vertical-in-line (3)
Thrust, lb:	12,000 @ 4000
WARHEAD	
Type:	Nuclear
GROUND SUPPORT MAJOR CONTRACTORS	
Launcher:	Boeing
Fueling:	GFE
Handling & Service:	Bell, American Mach. & Foundry
Transport Vehicles:	GFE





E. Hull

RASCAL, **SECURED TO DB-47 by an outrigger pylon, is fueled on ground.**



Bell

MISSILE STREAKS TOWARD target during flight tests at Holloman ADC, N.M.

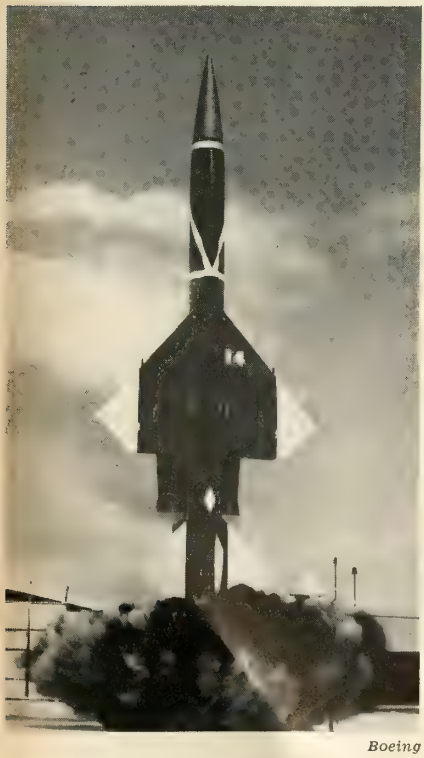
BOMARC

Bomarc 1M-99, the Air Force's supersonic pilotless interceptor, is launched vertically from an automatically opening launcher-shelter. Initial boost is supplied by a liquid rocket engine. When it reaches a speed at which its two ramjet engines become operational, they take over and climb to altitude, supplying the missile's cruise power.

An advanced version of *Bomarc* now in development, will employ a solid-propellant, external rocket booster in place of the liquid-propelled engine now in use. The range will be in excess of the present *Bomarc*, approximately 400 miles. This advanced version will be equipped with a nuclear warhead. Boeing Aircraft is planning a *Bomarc* training school on Harbor Island in Seattle scheduled for July.

Bomarc, at the moment, is the only missile in the U.S. arsenal capable of supplying the U.S. with medium-long-range defense by missiles. Essentially, it is a high-performance, unmanned aircraft and is probably the last of its type. Future anti-missile missiles and hyper-performance antiaircraft missiles will probably be rocket powered all the way. Meanwhile, the *Bomarc* base program could develop into one of the costliest in the entire U.S. defense program.

DESIGNATION:	IM-99
PRIME CONTRACTOR:	Boeing
STATUS:	Production
RANGE:	200-250 miles
VELOCITY:	Mach 2.5 max.
FRAME	
Manufacturer:	Boeing
Length (Overall), ft:	46.7
Diameter (Body), ft:	3
Span, ft:	18.17
Weight (Gross), lb:	15,000+
Material (Major):	Aluminum, stainless steel & magnesium
GUIDANCE	
Manufacturer:	Westinghouse
Type:	GCC/radar homing
POWER PLANTS	
First Stage (Booster)	
Manufacturer:	Aerojet
Propellants:	JP-4 and WFNA
Type & Number:	Liquid uncooled (1)
Thrust, lb:	35,000 (42,000 later model)
Second Stage	
Manufacturer:	Marquardt
Propellants:	Liquid
Type & Number:	24 inch ramjet (2)
Thrust, lb:	10,000-12,000
WARHEAD	
Type:	Nuclear
GROUND SUPPORT MAJOR CONTRACTORS	
Launcher:	AMF, Food Machinery
Fueling:	Minneapolis-Honeywell, Brown Instruments
Radar & Ground Control:	Westinghouse, Remington Rand
Handling & Service	Burns & Roe, Farnsworth Elect.
Transport Vehicles:	Burns & Roe, AMF



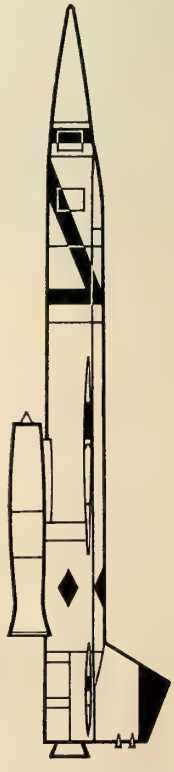
Boeing

INITIAL BOOST from liquid engine.

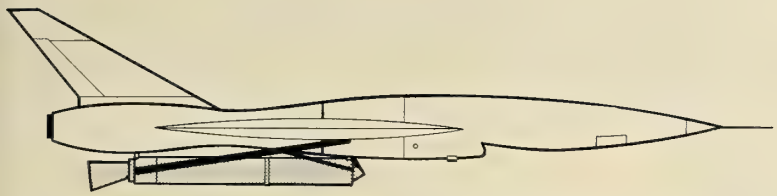


Boeing

VERTICAL LAUNCH from shelter.



GOOSE



Goose is a large, long-range missile with a primary role to save the lives of SAC bomber crews and to enable them to complete their missions. It is a plastic, rocket-boosted, turbo-jet-powered decoy designed, developed and produced by Fairchild Engine & Airplane Corp. It is in the flight-test stage, and has produced one of the most trouble-free initial flight test records of any missile to date.

Zero-launched by solid propellant a single JATO-type booster, the *Goose* is designed to be launched so that it goes in in advance of attacking bombers with the hope that it will (a) confuse enemy radar and (b) tempt the enemy into expending its defensive hardware (AA missiles and shells) before the actual bombers come over the target with their payloads.

Gooses would be launched with a variety of target-simulating systems aimed at activating all the different kinds of defensive equipment and homing methods. Actually, there is no reason why some of these might not also be occasionally equipped with explosive payloads, in order to destroy specific enemy defensive targets on which they might be programmed to home.

The *Goose* is slated to be ordered into production shortly. It will be deployed an operated by SAC.

DESIGNATION:	SM-73
PRIME CONTRACTOR:	Fairchild
STATUS:	Development
RANGE:	2,000 miles +
(Ceiling:	50,000 ft. +)
VELOCITY:	High subsonic
FRAME	
Stages:	2
Length (Overall), ft:	60 (approx.)
Diameter (Body), ft.	4.5 (approx.)
Span, ft:	32 (approx.)
Material (Major):	Plastic
GUIDANCE	
Type:	Inertial
POWER PLANTS	
First Stage (Booster)	
Propellants:	Solid
Type & Number:	JATO (1)
Thrust, lb:	100,000 (approx.)
Second Stage	
Propellants:	JP
Type & Number:	Turbojet (1)
Thrust, lb:	5000+



USAF

DRAMATIC shot of decoy missile *Goose* zero-launched.



USAF

BIRD IS DESIGNED to protect bomber crews over enemy territory.

ATLAS

The SM-65 *Atlas*, the United States' first intercontinental ballistic missile project, is currently entering the final phase of its development program.

Several of the giant missiles have been fired since their first flight last June, with varying degrees of success. First flights were plagued with component failures ("bugs"), which now seem to be a thing of the past. In all flights, the missile has been powered only by twin booster engines. The next phase of the development program booster and sustainer engines.

Atlas begins its flight with all three engines in operation, a total of approximately 400,000 pounds of thrust. Several seconds after blast-off, the booster engines drop away and the missile continues with the lower thrust sustainer. Two small verniers located on the lower portion of the body supply roll control and thrust adjustment throughout powered flight.

DESIGNATION: SM-65
PRIME CONTRACTOR: Convair, Ramo-Wooldridge
STATUS: Development production
RANGE: 5500-6200 miles
VELOCITY: 15,000 mph max.
FRAME
- Stages: (2)
- Manufacturer: Convair
- Length (Overall), ft: 75 (approx.)
- Diameter (Body), ft: 10
- Weight (Gross), lb: 243,000
- Material (Major): Steel

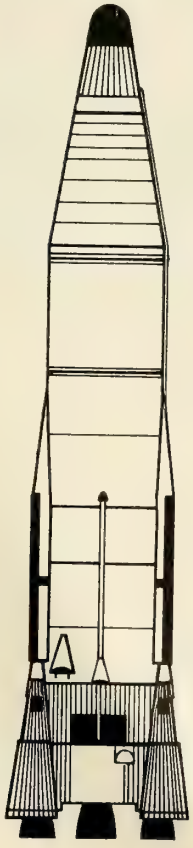
GUIDANCE
- Manufacturer: GE/Burroughs
- Type: Radar-Doppler Command (Later models TITAN pure inertia)

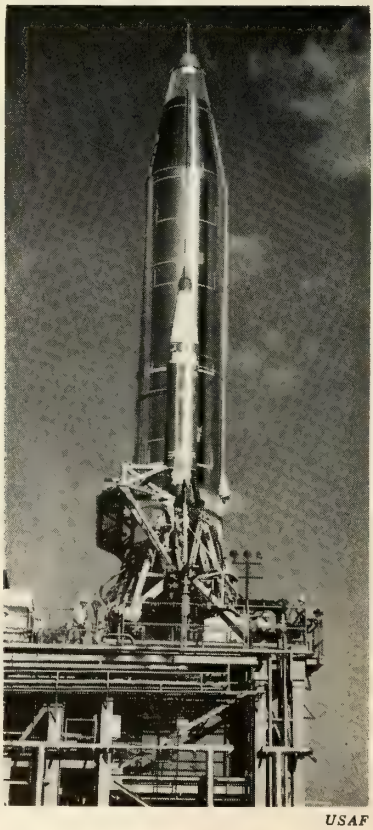
POWER PLANTS
First Stage (Booster)
- Manufacturer: Rocketdyne
- Propellants: Liquid oxygen and kerosene
- Type & Number: Regenerative liquid (2)
- Thrust, lb: 300,000 @ 150,000

Second Stage
- Manufacturer: Rocketdyne
- Propellants: Liquid oxygen and kerosene
- Type & Number: Regenerative liquid (1)
- Thrust, lb: 100,000

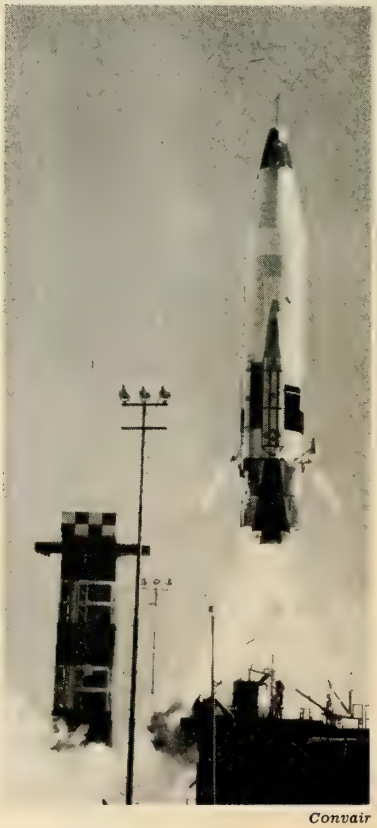
WARHEAD
- Type: Nuclear

GROUND SUPPORT MAJOR CONTRACTORS
- Launcher: Consolidated Western Steel, National Steel
- Fueling: Flexonics Corp., Reaction Motors
- Radar & Ground Control: Norden-Ketay, Potter Instrument
- Handling & Service: Goodyear Aircraft
- Transport Vehicles: Goodyear Aircraft
- Check Out Equipment: Caterpillar





USAF
ATLAS **ready for flight at Canaveral.**



Convair
BOOSTER and Vernier engines.

MACE



Martin

MACE **IS BOOSTED from trailer launcher at overland range.**



Martin

A 100,000-LB. thrust rocket starts *Mace* **on its flight.**

In the Tactical Air Command, the TM-76 *Mace* is the first of a second generation of aerodynamic cruise missiles. It is scheduled to replace the *Matador*, the Air Force's first pilotless bomber.

Mace is actually an improved *Matador* with increased range, speed, and a superior guidance system. In combat, tactical units will use the *Mace* to augment tactical bombers and fighter bombers.

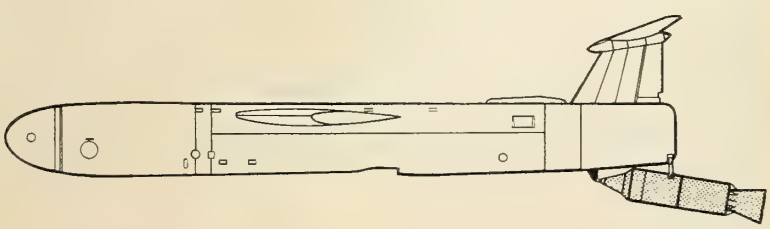
The missile will use either inertial or ATRAN guidance, depending upon the mission. The two systems are fundamentally interchangeable, with only minor production changes needed on the missile. The ATRAN guided *Mace* is designated the TM-76A, and the Inertial *Mace* is known as the TM-76B.

The inertial system, made by AC Sparkplug Division of General Motors, is a form of "memory navigation" which requires the location of launch point and target point for a successful mission.

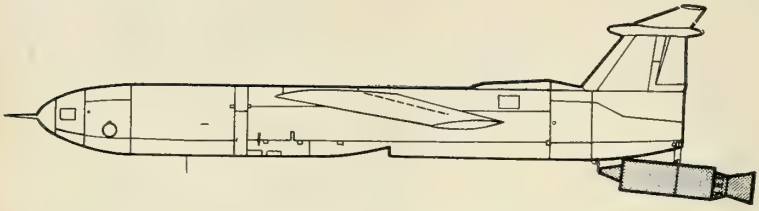
ATRAN, made by Goodyear Aircraft Corp., is a map matching system. The system permits extremely low-level penetration. Martin-Baltimore is the prime systems contractor.

The replacement of the warhead section with a recovery kit permits reuse of the *Mace* missile through parachute recovery.

DESIGNATION:	TM-76
PRIME CONTRACTOR:	Martin
STATUS:	Production
RANGE:	700 miles max.
VELOCITY:	Mach 0.9 max.
FRAME	
Manufacturer:	Martin
Length (Overall), ft.	44
Diameter (Body), ft:	4.5
Span, ft:	22.9
Weight (Gross), lb:	13,800
Material (Major):	Aluminum, magnesium
GUIDANCE	
Manufacturer:	Goodyear/AC
Type:	ATRAN/inertial
POWER PLANTS	
Booster	
Manufacturer:	Thiokol
Propellants:	Solid
Type & Number:	Cast JATO (1)
Thrust, lb:	100,000
Sustainer	
Manufacturer:	Allison
Propellants:	JP
Type & Number:	J-33-A-41 turbojet (1)
Thrust, lb:	5200
WARHEAD	
Type:	Nuclear
GROUND SUPPORT MAJOR CONTRACTORS	
Launcher:	Goodyear
Fueling:	Goodyear
Radar & Ground Control:	Reeves Instruments, Kaustine Co.
Handling & Service:	Goodyear, Trailmobile
Transport Vehicles:	Goodyear, Four-Wheel Drive Co.



MATADOR



The TM-61 *Matador* was the first operational missile in the Air Force. It has now been in operation—with the Tactical Air Command in overseas areas—for the past four years.

Three versions of the *Matador* have been developed to date. The first, TM-61A, was equipped with a single MSQ radar guidance system. This system requires line-of-sight communication.

The TM-61C, in addition to the MSQ radar guidance system, employs the Shanicle system. The Shanicle system is believed to be the first known use of the Hyperbolic grid system. This is the creation of a grid pattern of radio waves by two separate transmitters. One transmitter directs the azimuth, the second the range.

The latest version of the *Matador* is the TM-61B. This model is several feet longer than the original version, and has clipped wings. It is reported to have greater range, as well as an improved guidance system requiring no assistance from the ground once the missile is launched. This version has now evolved into the *Mace* TM-76.

DESIGNATION:	TM-61C
PRIME CONTRACTOR:	Martin
STATUS:	Service use
RANGE:	700 miles
VELOCITY:	Mach 0.9 max.

FRAME	
Manufacturer:	Martin
Length (Overall), ft:	39.7
Diameter (Body), ft:	4.5
Span, ft:	27.85
Weight (Gross), lb:	12,000
Material (Major):	Aluminum
GUIDANCE	
Manufacturer:	GFE, Martin
Type:	MSQ Radar/Shanicle
POWER PLANTS	
Booster	
Manufacturer:	Thiokol
Propellants:	Solid
Type & Number:	Cast JATO (1)
Thrust, lb:	52,000
Sustainer	
Manufacturer:	Allison
Propellants:	JP
Type & Number:	J-33 turbojet (1)
Thrust, lb:	4600
WARHEAD	
Type:	Nuclear
GROUND SUPPORT MAJOR CONTRACTORS	
Launcher:	Goodyear
Fueling:	Goodyear
Radar & Ground Control:	Reeves Instruments, Kaustine Co.
Handling & Service:	Trailmobile, Goodyear
Transport Vehicles:	Goodyear, Four-Wheel Drive Co.



Martin

MARTIN'S *Matador* can transport a 3,000-lb. warhead.



Martin

TACTICAL WINGS of the *Matador* are now operational.

SNARK

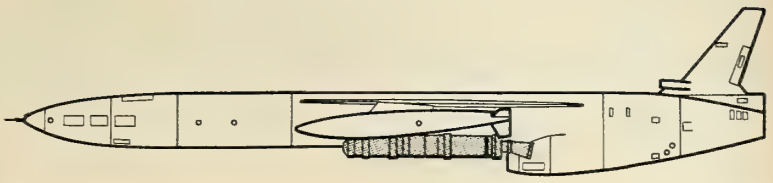
The Air Force surface-to-surface missile, the SM-62 *Snark*, is a high-altitude, swept-wing, single-engine, jet-propelled intercontinental guided missile. The Northrop *Snark* is the only operational intercontinental missile in the free world.

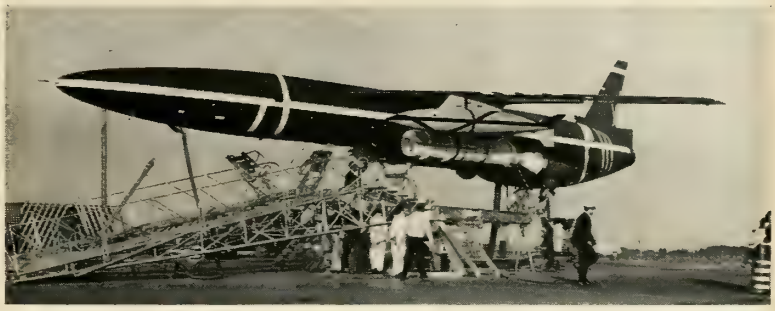
It has slim fuselage lines, with high-aspect ratio wings mounted near top and slightly forward of center of fuselage. Tail consists only of a vertical stabilizer. Engine air intake is located under fuselage and aft of wing.

Snark is powered during cruise flight by a Pratt & Whitney J-57 turbojet engine. Aerojet-General Corp. supplies the zero-length solid-propellant boosters which hurl it into the air.

The demand for an operational intercontinental missile and the advanced state of development of the *Snark* rang the death knell for the *Navaho* late last year. *Snark* will reign supreme in the intercontinental field until the advent of the operational ICBM. Meanwhile, *Snark* continues to post an admirable flight record.

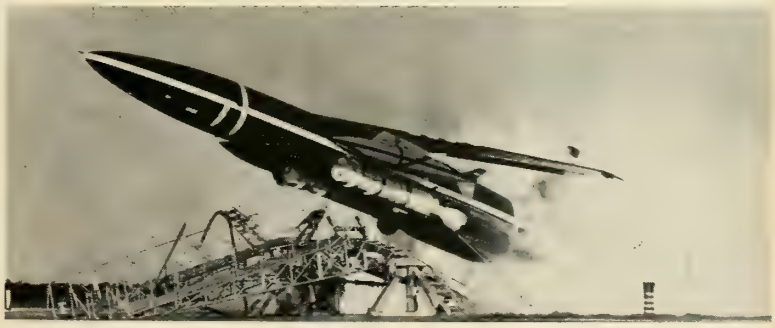
DESIGNATION:	SM-62
PRIME CONTRACTOR:	Northrop
STATUS:	Development, production, service use
RANGE:	5,000-6,500 miles
VELOCITY:	Mach 0.9 max.
FRAME	
Manufacturer:	Northrop
Length (Overall), ft:	74
Diameter (Body), ft:	4.5
Span, ft:	42
Weight (Gross), lb:	50,000 (approx.)
Material (Major):	Aluminum, magnesium
GUIDANCE	
Manufacturer:	Northrop
Type:	Stellar inertial
POWER PLANTS	
Booster	
Manufacturer:	Aerojet
Propellants:	Solid
Type & Number:	Cast JATO (2)
Thrust, lb:	66,000 @ 33,000
Sustainer	
Manufacturer:	Pratt & Whitney
Propellants:	Liquid
Type & Number:	J-57 turbojet (1)
Thrust, lb:	11,000
WARHEAD	
Type:	Nuclear
GROUND SUPPORT MAJOR CONTRACTORS	
Launcher:	American Car & Foundry
Fueling:	GFE
Radar & Ground Control:	Hallamore Electronics, Radiophone Co.
Handling & Service:	GFE
Transport Vehicles:	GFE





Northrop

MISSILE IS READIED for long range test flight from Cape Canaveral, Fla.



Northrop

THE 25-TON *Snark* clears its zero-length launcher with a 66,000-lb. assist.



Carl Byoir

***SNARK* CAN BE quickly readied for action with its mobile transport-launcher.**

THOR

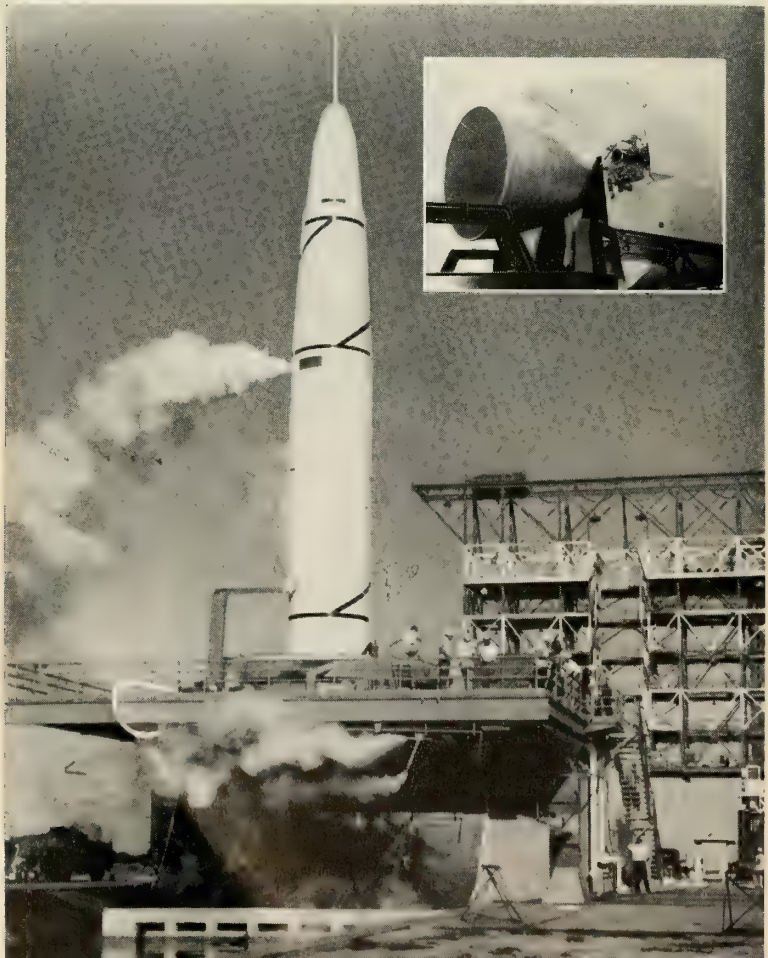
The Douglas *Thor* will play a major role in future weapons and space flight programs. The *Thor* will probably be picked (over the *Jupiter*) as the free world's IRBM arm of retaliation. *Thor* has been slated to boost three lunar probes and launch a reconnaissance satellite, in addition to its role in the *Thor-Able* re-entry test vehicle program.

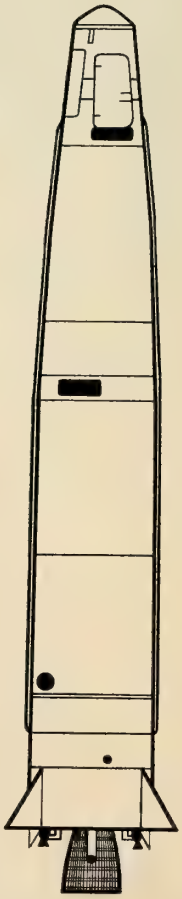
Final determination on the number of IRBM squadrons to be deployed, (*Thor* and *Jupiter*), will not be made until later this year.

Thor is powered by a 150,000-lb. thrust liquid propellant engine now being produced at Rocketdyne Neosho. Propellants are liquid oxygen and RP-1, a high grade kerosene. In addition to the gimbaling action of the sustainer, thrust adjustment and roll control are obtained by two vernier engines located at the base of the missile on each side of the sustainer (see insert).

DESIGNATION:	SM-75
PRIME CONTRACTOR:	Douglas, Ramo-Wooldridge
STATUS:	Development production
RANGE:	1,500-2,200 Miles
VELOCITY:	10,000 mph max.
FRAME	
Manufacturer:	Douglas
Length (Overall), ft:	62
Diameter (Body), ft:	9
Weight (Gross), lb:	100,000
Material (Major):	Aluminum
GUIDANCE	
Manufacturer:	AC Spark Plug
Type:	Inertial
POWER PLANT	
Manufacturer:	Rocketdyne
Propellants:	Liquid Oxygen and Kerosene
Type & Number:	Regenerative cooled, liquid (1)
Thrust, lb:	165,000
WARHEAD	
Type:	Nuclear
Nose Cone:	GE
GROUND SUPPORT MAJOR CONTRACTORS	
Launcher:	Food Machinery
Fueling:	Air Prod., Cambridge Corp.
Radar & Ground Control:	AC Spark Plugs
Handling & Service:	Douglas, Food Machinery
Transport Vehicles:	Douglas, Food Machinery

LIQUID OXYGEN is "topped off" as *Thor* is prepared for test flight from the Cape.
USAF; (Inset) Howard Levy





TITAN

The Air Force's *Titan* WS-107 intercontinental ballistic missile's airframe is under construction at the Martin Co., Denver. Development of the *Titan* was ordered late in 1955.

Titan is a two-stage missile. The first stage engine will transport the vehicle to altitude before the final stage ignites, differing from the *Atlas* system where all three motors are fired simultaneously on the ground.

Titan does not duplicate the *Atlas*, although some of its components are common to both systems. The airframes and propulsion systems are quite different, however, so it is unlikely that the two missiles can be considered interchangeable.

DESIGNATION: SM-68
PRIME CONTRACTOR: Martin, Ramo-Wooldridge
STATUS: Research-Development
RANGE: 5,500 miles max
VELOCITY: 15,000 mph max.

FRAME
- Stages: 2
- Manufacturer: Martin
- Length (Overall), ft: 90
- Diameter (Body), ft: 10
- Weight (Gross), lb: 222,000
- Material (Major): Aluminum

GUIDANCE
- Manufacturer: Arma, Minneapolis-Honeywell/Bell Tel. Lab., Remington Rand
- Type: Inertial/radio inertial

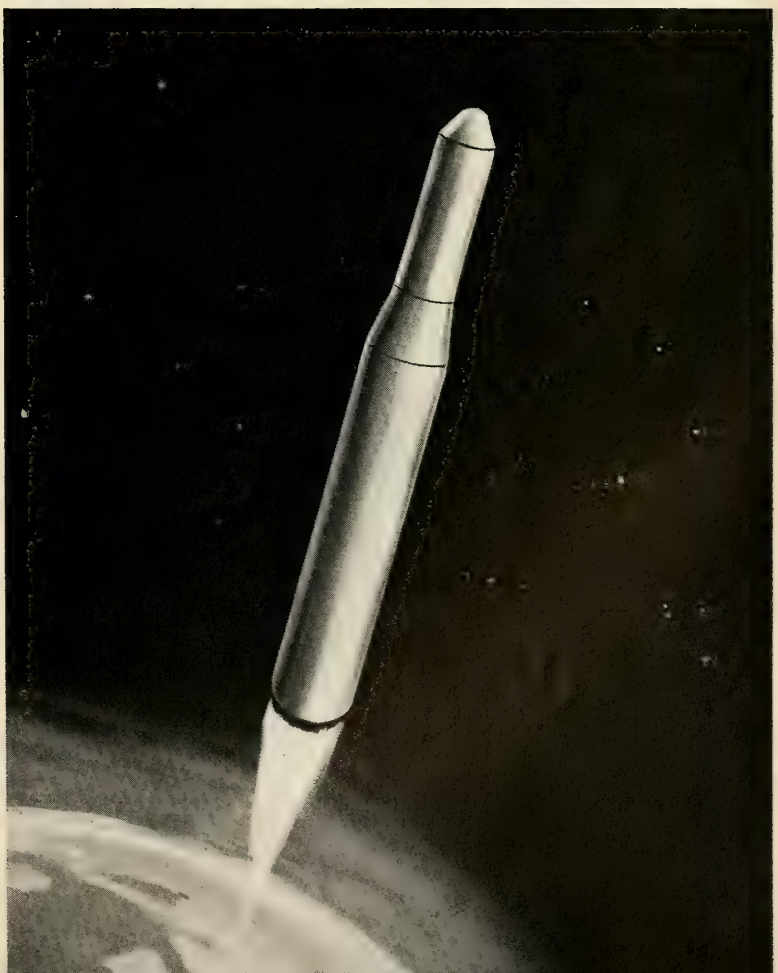
POWER PLANTS
- First Stage (Booster)
  - Manufacturer: Aerojet
  - Propellants: Liquid Oxygen and JP-6
  - Type & Number: Regenerative, liquid (2)
  - Thrust, lb: 300,000
- Second Stage
  - Manufacturer: Aerojet
  - Propellants: Liquid Oxygen and JP-6
  - Type & Number: Regenerative cooled liquid (1)
  - Thrust, lb: 60,000

WARHEAD
- Type: Nuclear
- Nose Cone: Avco

GROUND SUPPORT MAJOR CONTRACTORS
- Launcher: Kaiser Steel, Baldwin-Lima-Hamilton, Space Corp.
- Fueling: Air Products
- Radar & Ground Control: Hallamore Electronics
- Handling & Service: Hallamore Electronics
- Transport Vehicles: North American



AN ARTIST'S CONCEPTION of the two-stage Martin *Titan* ICBM in flight.



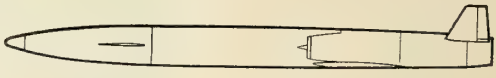
DYNA-SOAR

Dyna-Soar had its birth first in 1935 as an idea and design study by Dr. Eugen Sänger. Now it is in the design-study stage under a competition between two major industrial teams—one under Boeing, consisting of Ramo-Wooldridge, GE-Syracuse; NAA's Autonetics and Missile Development divisions, Aerojet-General, and Chance-Vought; the other under Martin and consisting of Bell, Goodyear, AMF, Bendix and Minneapolis Honeywell. *Dyna-Soar* would have a range of 12,000-to-25,000 miles; would be rocket-boosted to a 100-to-150-mile altitude and then would glide (assisted by small sustainer rockets) over target and to a landing. The vehicle would be manned.

GREEN QUAIL

Green Quail is one of a large number of diversionary missiles under development for the Air Force. It is reported to be a surface-to-surface bird of the *Corvus* family. Reported contractors are: McDonnell Aircraft for prime systems and Sommers Gyroscope for guidance. Though first flights were scheduled for sometime in 1958, there have been no reports of such a flight yet. The role of the missile as a coutermeasures device for attacking aircraft is increasing in importance. It is reported to be encountering technical problems, particularly in the engine. Suggested launching platforms are the B-52 and B-70.

HOUND DOG



Hound Dog was the subject of an intense round of proposing by almost all the major airframe companies last fall with the winner being North American Aircraft. The missile is understood to be a ramjet-powered air-to-surface bird, and is a follow-on to the Bell *Rascal*. Original design specifications called for one under each wing of a B-52 with the capability built into a plane-carried computer to shoot simultaneously at two different targets. Guidance is probably a form of inertial navigation, corrected by doppler radar.

MINUTEMAN



Minuteman is a 5,000 mile solid propellant ICBM to replace *Atlas* and *Titan*. Contractors are not yet named. Vehicles would be placed on subterranean platforms scattered around an individual launching site. The individual launchers would control a number of missiles, and the launcher would also be underground. Solid propellants would allow long storage without upkeep, and the underground storage protecting from weather. The *Minuteman* would be ready to go at all times. The number of troops to operate will be substantially smaller than *Atlas* and *Titan*.

WAGTAIL

Wagtail is an air-to-ground missile is probably the most radical of all concepts now in the research and development phase. It reportedly used forward-firing rockets after launch to achieve a very low velocity (approaching zero) before ignition of the solid propellant engine. This means that the missile can be launched from a low flying bomber and then climb over obstacles such as hills to get to its target. Contractors for the *Wagtail* have not been named but Minneapolis-Honeywell is rumored to be either the prime or the guidance system sub-contractor. It is contemplated that *Wagtail* will be used by both the B-52 and the B-70 chemical bomber.

HAWK I

The Army's surface-to-air guided missile, *Hawk*, is designed to be used primarily against low-flying craft. The missile will be deployed by both the Army and the Marine Corps. *Hawk* is carried on a launcher from which three missiles can be fired in rapid succession. This highly mobile system is capable of being transported with a minimum number of vehicles on the highway, or by helicopter and conventional aircraft.

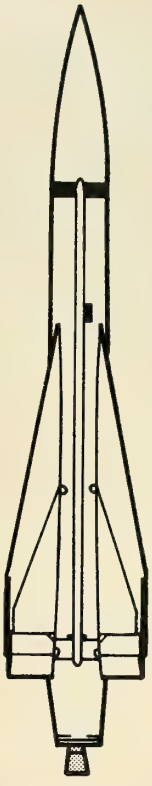
Unusual radar instrumentation has been designed and installed in the *Hawk* to gain effectiveness in the so-called "blind zone" of conventional radars.

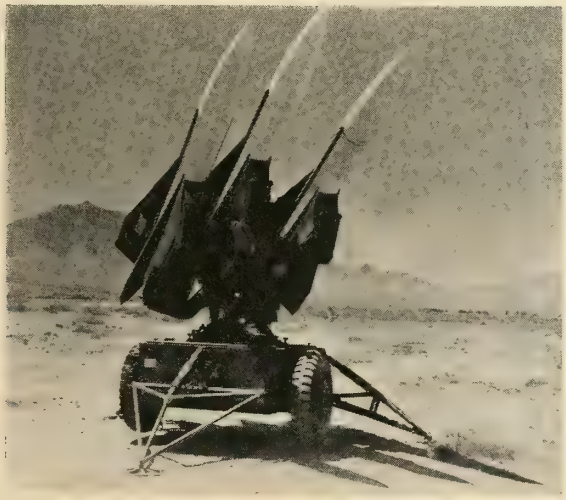
The *Hawk* uses a solid propellant system developed by Thiokol Chemical Corp. The motors are currently in production at Aerojet Sacramento.

Each battery of 36 missiles requires some 40 acres for emplacement. For safety and economy, the missiles are stored underground. The twelve launcher emplacements are covered by balloon-like domes. Missiles are fired through domes, which protect launchers against the weather.

First emplacements will be located in New York City and Washington, D.C. to complement *Nike* defenses of those major metropolitan complexes.

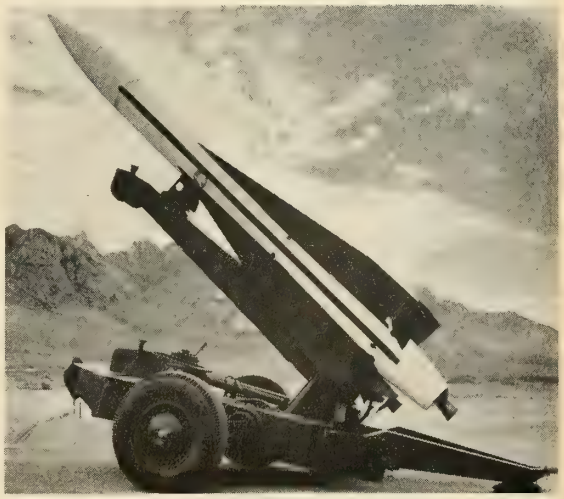
DESIGNATION:	XM3
PRIME CONTRACTOR:	Raytheon
STATUS:	Development production
RANGE:	22 miles max.
FRAME	
Stages:	2
Manufacturer:	Northrop
Length (Overall), ft:	17
Diameter (Body), ft:	1.2
Span, ft:	4
Weight (Gross), lb:	1200
Material (Major):	Steel
GUIDANCE	
Manufacturer:	Raytheon
Type:	Radar homing
POWER PLANTS	
First Stage	
Manufacturer:	Aerojet, Thiokol
Propellants:	Solid
Type & Number:	Cast (1)
Second Stage	
Manufacturer:	Aerojet, Thiokol
Propellants:	Solid
Type & Number:	Cast (1)
WARHEAD	
Type:	High Explosive by Picatinny Arsenal
GROUND SUPPORT MAJOR CONTRACTORS	
Launcher:	Northrop, Food Machinery
Radar & Ground Control:	Raytheon
Handling & Service:	Raytheon, Northrop, Food Machinery
Transport Vehicles:	Northrop, Food Machinery





Army

VERSATILE *Hawk* **can be transported on roads by helicopter.**



Army

RAYTHEON is prime contractor development and production.

NIKE-AJAX

The last *Nike-Ajax* has now been shipped—passing from the production scene. It was the United States' first surface-to-surface missile, with over 10,000 manufactured and delivered to installations throughout the country. It is currently undergoing replacement by the *Nike-Hercules*.

The original *Nike* project was initiated in 1945, after years of guided missile research by the Bell Telephone Labs. The Western Electric Co. was the prime contractor to the Army, responsible for development and production of the system. Douglas was responsible for frame and launching components.

Nike-Ajax is attached to a solid propellant booster half the missile's length. The booster accelerates the missile to supersonic speeds, separates in a matter of seconds, and falls to a predetermined booster area.

Nike-Ajax is normally fired from an almost vertical position, and is therefore capable of meeting an enemy attack from any direction. Calculations are made and decisions reached electronically. Any evasive action by the target plane is futile—it is detected instantaneously — and the missile's course is altered accordingly.

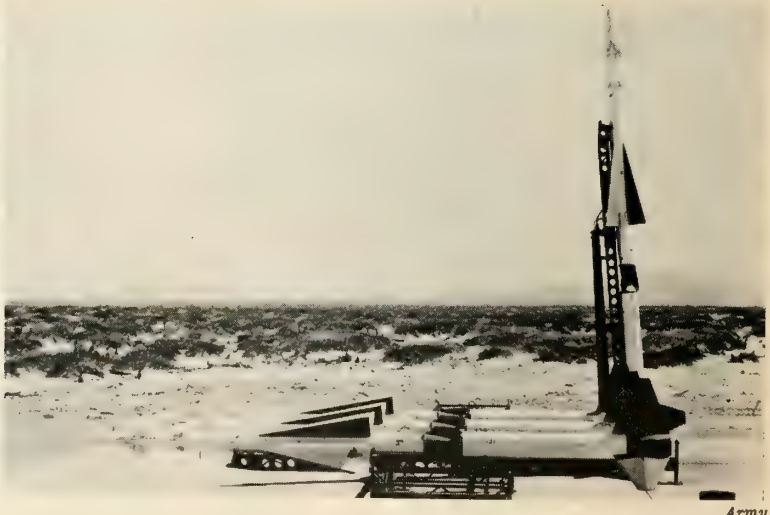
DESIGNATION:	XSAM-A-7
PRIME CONTRACTOR:	Western Electric
STATUS:	Production, service use
RANGE:	35 miles max.
VELOCITY:	1500 mph
FRAME	
Stages:	2
Manufacturer:	Douglas, Borg-Warner (booster)
Length (Overall), ft:	21 (35.5 with (booster)
Diameter (Body), ft:	1
Span, ft:	4
Weight (Gross), lb:	2000+ (Missile) plus Booster)
Material (Major):	Aluminum, magnesium and steel
GUIDANCE	
Manufacturer:	Western Electric
Type:	Command
POWER PLANTS	
First Stage (Booster)	
Manufacturer:	Goodyear
Propellants:	Solid
Type & Number:	Cast uncooled (1)
Second Stage	
Manufacturer:	GFE
Propellants:	Nitric acid and JP
Type & Number:	Liquid, cooled (1)
Thrust, lb:	2600
WARHEAD	
Type:	High explosive
GROUND SUPPORT MAJOR CONTRACTORS	
Launcher:	Douglas, Consolidated Western Steel
Radar & Ground Control:	Western Electric
Handling & Service:	Douglas, Wayne Pump
Transport Vehicles:	Fruehauf





Army

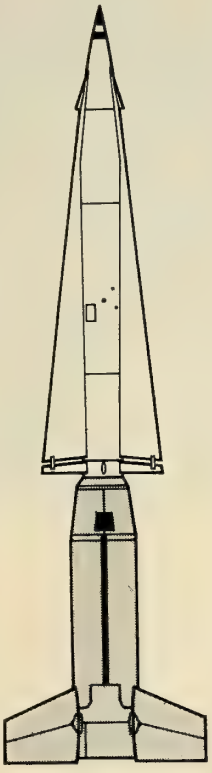
NIKE **poised for launching at White Sands.**



Army

THE *AJAX* has been installed at over 100 sites in 15 defense areas within the U.S.

NIKE-HERCULES



The *Nike-Hercules*, with many times the destructive power of the original *Nike-Ajax*, has reached a substantial rate of production, according to the Western Electric Company, prime contractor of the system.

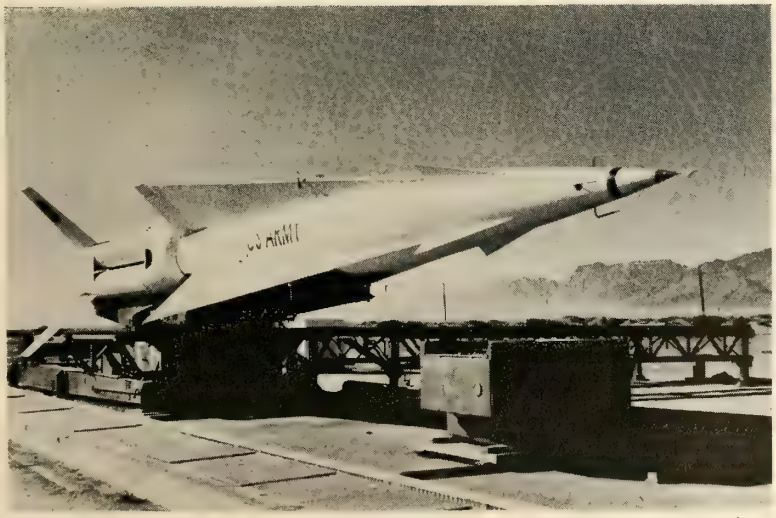
The new system will be in the hands of operational *Nike* batteries around the country in the relatively near future, with first units to become operational in northeast U.S. and the Midwest. *Hercules* systems may eventually replace all *Ajax* systems. The *Nike-Hercules* system will make full use of present *Nike-Ajax* sites and components. Replacement of the *Ajax* ground guidance equipment and modifications to launching equipment will make it possible to fire both *Ajax* and *Hercules*.

Research and development studies on the *Hercules* were made by the Army Ordnance Corps, Bell Telephone Labs, Western Electric and Douglas.

The ground guidance and control equipment, plus the electronic guidance package, is manufactured by the Western Electric Co.

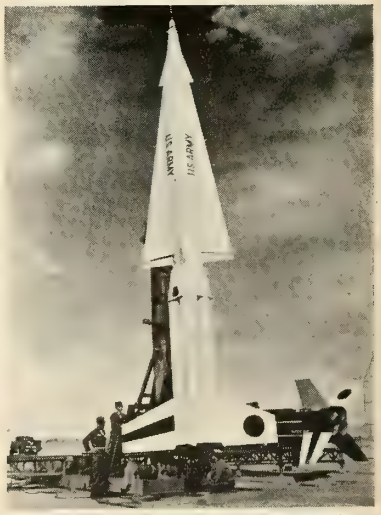
The *Hercules* system also uses three radars, a computer, automatic plotting boards, power generators and miscellaneous equipment in the Ground Guidance system.

DESIGNATION:	XSAM-A-25
PRIME CONTRACTOR:	Western Electric
STATUS:	Production
RANGE:	75 miles max.
VELOCITY:	2200 mph (approx.)
FRAME	
Stages:	2
Manufacturer:	Douglas, Goodyear, Borg Warner
Length (Overall), ft:	27 (41.5 with booster)
Diameter (Body), ft:	2.5
Span, ft:	8.75 (approx.)
Material (Major):	Aluminum, magnesium and steel
GUIDANCE	
Manufacturer:	Western Electric
Type:	Command
POWER PLANTS	
First Stage (Booster)	
Manufacturer:	Radford Arsenal
Propellants:	Solid
Type & Number:	Cast uncooled (4)
Second Stage	
Manufacturer:	Thiokol
Propellants:	Solid
Type & Number:	Cast, uncooled (1)
WARHEAD	
Type:	Nuclear
GROUND SUPPORT MAJOR CONTRACTORS	
Launcher:	Douglas, American Machine & Foundry, Wayne Pump
Radar & Ground Control:	Western Electric
Handling & Service:	Douglas, Consolidated Western Steel, Wayne Pump
Transport Vehicles:	Douglas, Fruehauf



Army

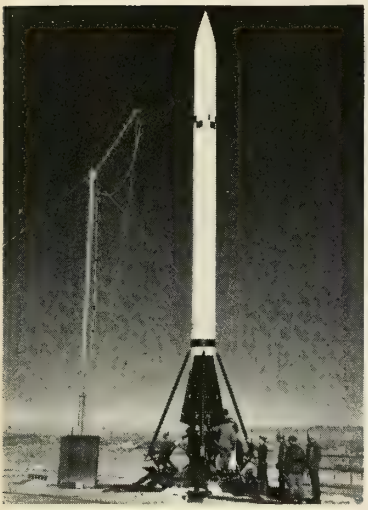
THE *Nike-Hercules* will be integrated into present *Ajax* launching sites.



Army

LAUNCHING requires four *Ajax* boosters.

CORPORAL



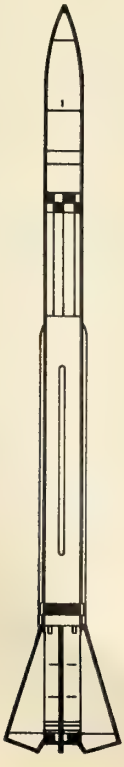
Army

SLENDER 46-ft. *Corporal* **erected on pad.**



Army

THE *CORPORAL* **is positioned on its pad by a LeTourneau transport-erector.**



The Army's *Corporal* was this country's first ballistic missile.

The liquid-propelled, 30-inch diameter missile is produced by the Firestone Tire & Rubber guided missile division.

Topmost section, as it sits on the launching pad, is the 8-foot-long nose which houses the warhead. Immediately below, lies the guidance stowage compartment; followed, in sequence, by a cluster of cells to carry compressed air to pressurize the two propellant tanks, the propellant valve system, the rocket engine and the guidance vanes and rudders.

Also included in the aft compartment of the missile is the servo-motor system to actuate the jet vanes and rudders, as well as miscellaneous air pressure regulating valves.

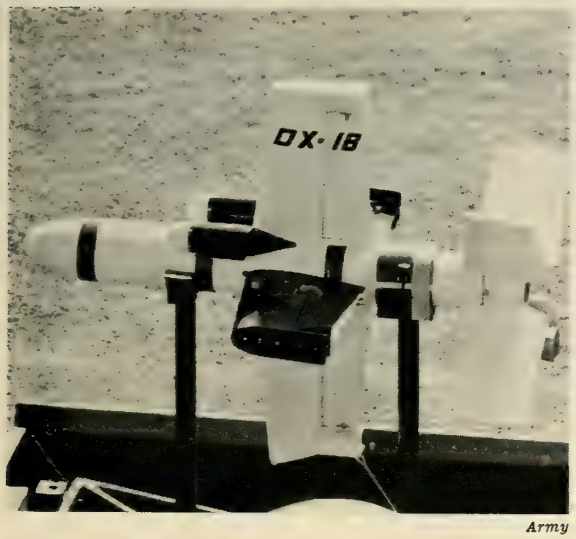
In *Corporal's* flight to its objective, it follows a ballistic trajectory. Visibility and weather conditions place no restrictions on its use.

The launcher is a simple device consisting of a light metal take-off pedestal. A self-propelled, electrically-operated erector places the missile in firing position, when ready, on the take-off pedestal.

Basic firing data is computed for the guidance equipment and entered as "dial settings" before the missile is launched. After the rocket is fired, minor corrections are made to the trajectory to insure and accurate impact. The 75-mile range missile is slated to be replaced in the near future by the *Sergeant*.

DESIGNATION:	XM4E1
PRIME CONTRACTOR:	Gilfillan, Firestone
STATUS:	Production, service use
RANGE:	100 miles max.
FRAME	
Manufacturer:	Firestone
Length (Overall), ft:	46
Diameter (Body), ft:	2.5
Weight (Gross), lb:	12,000
Material (Major):	Steel
GUIDANCE	
Manufacturer:	Gilfillan, Clary Multiplier Co.
Type:	Command
POWER PLANT	
Manufacturer:	Ryan
Propellants:	Nitric acid and aniline
Type & Number:	Liquid cooled (1)
WARHEAD	
Type:	High explosive or nuclear
GROUND SUPPORT MAJOR CONTRACTORS	
Launcher:	Firestone
Fueling:	Firestone, GFE
Radar & Ground Control:	Gilfillan, Motorola
Handling & Service:	Le Tourneau, Firestone
Transport Vehicles:	GFE

DART



Army

DART **WARHEAD is capable of penetrating heaviest armor.**



Army

THE *DART* will be employed by infantry and armored units.

The Army's wire guided missile, *Dart,* is a simple, but effective anti-tank, anti-placement weapon to be employed by infantry or armored units.

Dart is maneuverable enough to make it relatively safe from machine gun and anti-aircraft fire. It is propelled by a smokeless rocket propellant manufactured by Grand Central.

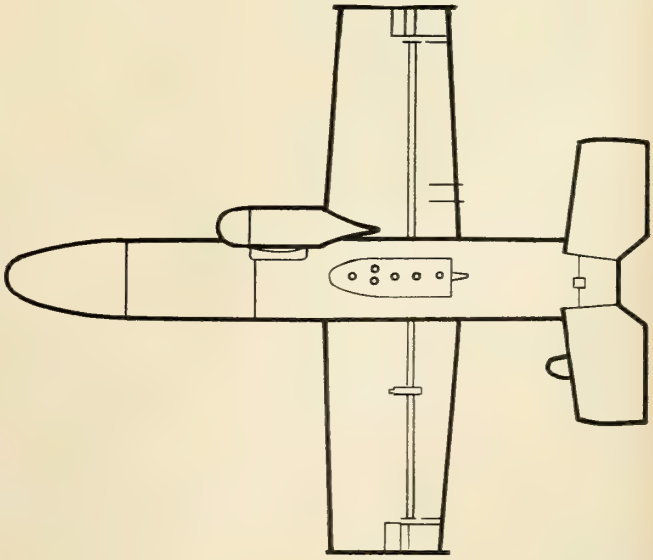
The guidance system automatically computes problems, and transmits the signals to the missile by means of electrical impulses through the wire. Guidance operation is through operator line-of-sight determination. *Dart* is launched from a light-weight launcher, and can be fired from either a fixed or mobile position. One man can fire.

The missile system was developed by the Aerophysics Development Corp., and is presently in production at the Utica Division of Curtiss-Wright.

DESIGNATION:	XSSM-A-23
PRIME CONTRACTOR:	Aerophysics Development Corp.
STATUS:	Production
RANGE:	6000 ft.
VELOCITY:	Mach 1
FRAME	
Manufacturer:	Utica-Bend
Length (Overall), ft:	5
Diameter (Body), ft:	.8
Span, ft:	3
Weight (Gross), lb:	100
GUIDANCE	
Manufacturer:	Wagner
Type:	Optical
POWER PLANT	
Manufacturer:	Grand Central
Propellants:	Solid
Type & Number:	Uncooled (1)
WARHEAD	
Type:	High explosive

GROUND SUPPORT MAJOR CONTRACTORS

Launcher:	Aerophysics Development Corp.
Fueling:	Grand Central
Radar & Ground Control:	Aerophysics Development Corp.
Handling & Service:	Aerophysics Development Corp.
Transport Vehicles:	GFE



HONEST-JOHN



Army

HONEST JOHN **is in service overseas with U.S. and NATO troop units.**



E. Hull

MISSILE USES a variety of warheads, including atomic.

The Army's *Honest John* is a free-flight rocket, having no electronic controls. It will be used in providing close fire support for ground operations. Extreme mobility and simplicity are incorporated in the rocket, which can be fired by less than six men, if it should be necessary.

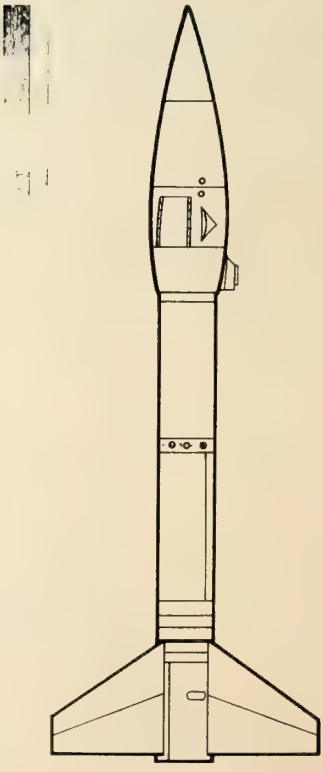
Honest John is propelled by a solid propellant rocket, and a slow spin is produced by small spin rockets. It is fired from a mobile, self-propelled launcher and can carry an atomic or high-explosive warhead.

The basic idea for a large calibre artillery rocket was first outlined to Douglas by Army Ordnance in June, 1950. Aerodynamics and engineering studies, under the technical supervision of the Redstone Arsenal, Huntsville, Alabama, dictated a number of modifications of what were the original specifications.

Effectiveness of the weapon was then demonstrated in a series of tests at the White Sands Proving Ground, New Mexico. Initial tests completed in August, 1951, justified production of additional models. Successful tests with the improved rockets resulted in contracts being let for large-scale production.

Major parts of the *Honest John* rocket—such as the head compartment, fins, pedestal and motor—are assembled at the factory or arsenal. Final assembly of the explosive warhead and fins to the rocket takes place near the firing site. The rocket is then rapidly moved forward on the self-propelled launcher.

DESIGNATION:	M-30
PRIME CONTRACTOR:	Douglas, Emerson Electric
STATUS:	Production, service use
RANGE:	18-20 miles
VELOCITY:	1120 mph
FRAME	
Manufacturer:	Douglas
Length (Overall), ft:	27
Diameter (Body), ft:	2.5
Span, ft:	8
Weight (Gross), lb:	6000
Material (Major):	Steel
GUIDANCE	
Type:	Unguided
POWER PLANT	
Manufacturer:	Hercules
Propellants:	Solid
Type & Number:	Cast (1)
WARHEAD	
Type:	High explosive
GROUND SUPPORT MAJOR CONTRACTORS	
Launcher:	Rock Island Arsenal
Transport Vehicles:	OTAC



JUPITER

Development of the *Jupiter* IRBM began in mid-1955 when the Army, Navy, and Chrysler Corp. met to study the feasibility of adopting an Army IRBM design for operational use within a fleet ballistic missile system. First contract for engineering and production work on the *Jupiter* missile system was awarded to Chrysler in June, 1956.

The *Jupiter*, designed by the Army's Ballistic Missile Agency of Huntsville, Alabama, is designed to transport a nuclear warhead over a 1,500 mile distance and slightly beyond. It is a missile that signifies the ultimate in simplicity—its constant diameter cylindrical body is slightly under 60 ft. in length and 9 ft. in diameter. The control and guidance section of the missile is located in a conical section forward of the top propellant kerosene tank. The warhead, mounted forward of the control section, is a continuation of the conical section with a bluff re-entry tip.

Scale models of the re-entry nose cone for the *Jupiter* were recovered successfully after being fired 3,000 miles over the Atlantic on a *Jupiter-C* test vehicle flight during the fall of 1957. Recently, an operational nose cone was recovered successfully after a 1,500 mile flight (see launch photo, below right).

Jupiter is powered by a Rocketdyne liquid propellant rocket engine, developing approximately 150,000-lb. thrust. Roll control is supplied by swiveling the exhaust of the gas generator.

DESIGNATION:	SM-78
PRIME CONTRACTOR:	Chrysler
STATUS:	Development, production
RANGE:	1500-2000 miles
VELOCITY:	10,000 mph
FRAME	
Manufacturer:	Chrysler
Length (Overall), ft:	58
Diameter (Body), ft:	8.75
Weight (Gross), lb:	105,000
Material (Major):	Aluminum
GUIDANCE	
Manufacturer:	Ford Instrument Co.
Type:	Inertial
POWER PLANT	
Manufacturer:	Rocketdyne
Propellants:	Liquid Oxygen and kerosene
Type & Number:	Regenerative cooled (1)
Thrust, lb:	150,000-165,000
WARHEAD	
Type:	Nuclear
Nose Cone:	Goodyear Aircraft



missiles and rockets, July 28, 1958

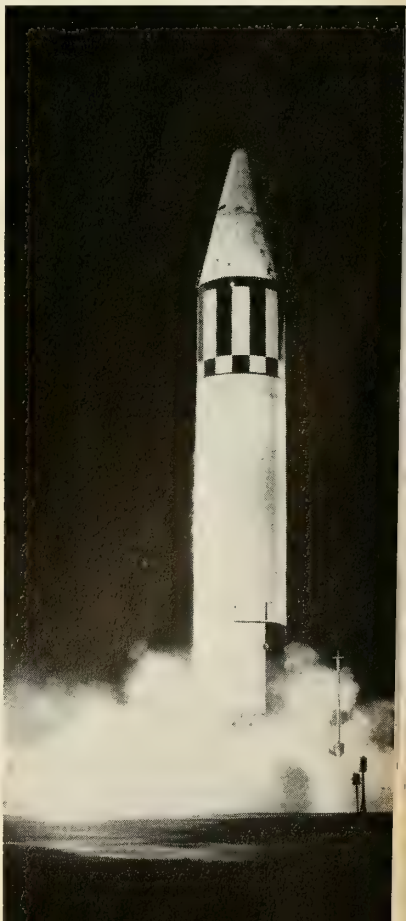
JUPITER **test vehicle shortly after launch, rises on a tail of flame.**

Army

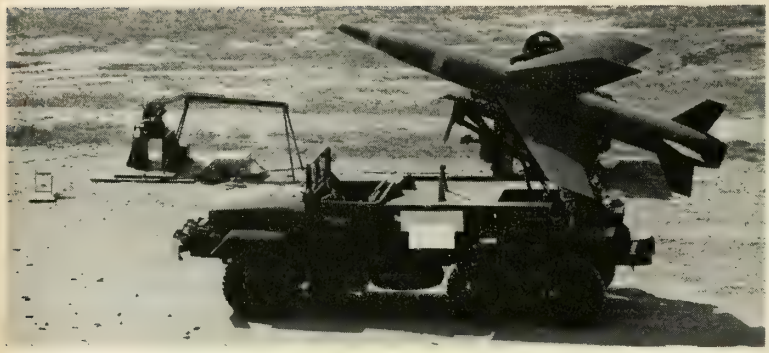


THE FIRST SUCCESSFUL *Jupiter* **re-entry nose cone tests Cape Canaveral.**

Army



LACROSSE



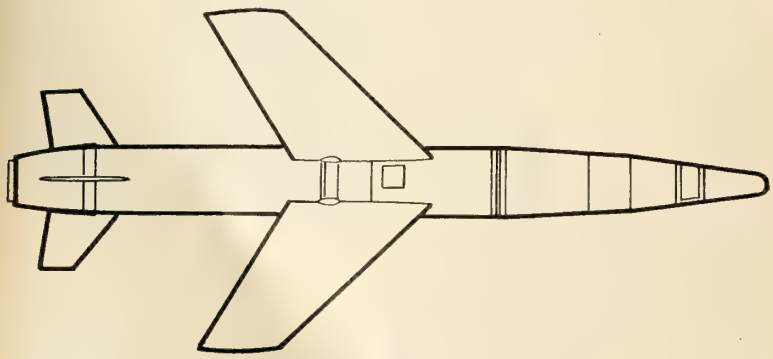
Army

LACROSSE **was developed by Cornell Aeronautical Lab, with production by Martin.**



Army

AN EARLY TEST MODEL of *Lacrosse* is prepared for launching at White Sands, N.M.



The *Lacrosse*, an Army surface-to-surface artillery guided missile, has been sucessfully developed and is in production, the Army announced early in 1957.

According to the Army, the present *Lacrosse* system, after being launched from a position in the rear of the combat area, is guided to its target by a forward observer. Using airborne control, the missile would be controlled to its target from a position above the battlefield, presumably by Army aircraft.

Because of its extreme accuracy and high payload, *Lacrosse* provides one-shot destruction of difficult targets such as pillboxes.

The present *Lacrosse* uses a launcher mounted on a stardard Army truck. According to Cornell Aeronautical Laboratory, work on a lightweight launcher, as well as other system equipment, is underway to make equipment transportable by helicopter.

Lacrosse has four fins positioned 45 degrees from the plane of the wings and the aft of the fuselage, which are movable for flight control and stability. The four swept wings and four movable tail fins, which control pitch, yaw and roll, snap into slots in the body.

Just prior to launching, the missile undergoes a complete test, using a missile automatic checker which tests all phases of the missile before firing. This equipment can be airlifted to battle areas if necessary.

DESIGNATION:	SSM-A-12
PRIME CONTRACTOR:	Cornell Aero Lab., Martin
STATUS:	Production
RANGE:	20 miles
VELOCITY:	Mach 2
FRAME	
Manufacturer:	Martin
Length (Overall), ft:	19.5
Diameter (Body), ft:	1.7
Span, ft:	9
GUIDANCE	
Manufacturer:	Federal Telephone Labs.
Type:	Terminal
POWER PLANT	
Manufacturer:	Thiokol
Propellants:	Solid
Type & Number:	Cast (1)
WARHEAD	
Type:	Nuclear capability
GROUND SUPPORT MAJOR CONTRACTORS	
Radar & Ground Control:	Federal Telecommunication, Farrand Optical

LITTLE JOHN

Little John was designed and developed by Redstone Arsenal to supplement the *Honest John.* It is a free-flight artillery weapon with high accuracy, simplicity of design and operation. The missile has no electronic controls. It has a range equivalent to medium-to-long-range artillery.

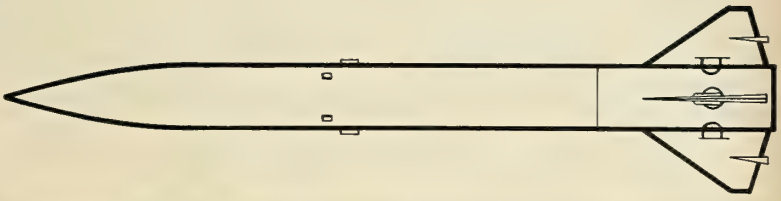
The dimensions of *Little John* are about one-third of *Honest John's,* and its weight one-sixth of its predecessor. *Little John* can be carried by helicopter and cenventional aircraft.

Even under severe weather conditions, *Little John* has remarkable accuracy. It is an artillery-type rocket intended for use by the Army airborne divisions.

This "baby brother" of the *Honest John,* combined with the *Lacrosse,* will eventually replace the *Honest John. Little John* represents the growth of a new family of rocket weapons that will ease logistical problems and provide a wider range of warhead selection. In combination with *Honest John, Lacrosse,* and *Sergeant,* the Army will have a tactical fire support that will have little need for close air support.

Propellant for the solid fueled rocket is produced by Allegheny Ballistics Lab, with Consolidated Western Steel supplying motor parts. Emerson Electric manufactures the air frame, and the Army Rock Island Arsenal provides the launchers.

DESIGNATION:	XM-47
PRIME CONTRACTOR:	Emerson Electric
STATUS:	Development production
RANGE:	10 miles
VELOCITY:	1860 mph
FRAME	
Manufacturer:	Douglas, Emerson Electric
Length (Overall), ft:	12
Diameter (Body), ft:	1
Span, ft:	2.5
Weight (Gross), lb:	980
Material (Major):	Steel and aluminum
GUIDANCE	
Type:	Unguided
POWER PLANT	
Manufacturer:	Allegheny Ballistics Lab.
Propellants:	Solid
Type & Number:	Cast (1)
WARHEAD	
Type:	High explosive by Picatinny Arsenal
GROUND SUPPORT MAJOR CONTRACTORS	
Launcher:	Rock Island Arsenal





Army

THE 12-FT. ***Little John*** **leaves its launching rail in short-range flight at White Sands.**



Army

EVEN THE SIMPLE free-flight ***Little John*** **requires an array of ground support gear.**

REDSTONE

The *Redstone* is a medium range (200-300 miles) liquid propellant powered ballistics missile. It recently entered operational service after many months of development testing. A modified version of the *Redstone, (Jupiter-C)*, was the power behind the launching of the United States' first satellite. Earlier models of the *Jupiter-C* were rigged as IRBM re-entry test vehicles.

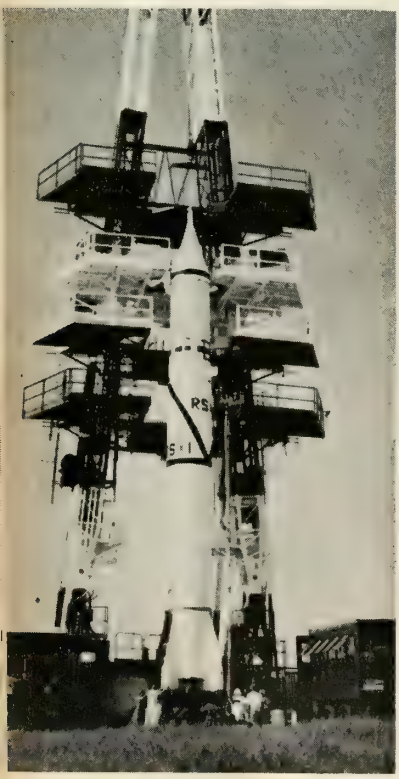
The missile is approximately 63 ft. long and 5 ft. 10 in. in diameter. Earlier prototypes varied in length from 62 to 69 ft. Major credit for the design and development of the *Redstone* belongs to the Wernher von Braun team of former German scientists at the Army's Ballistics Missile Agency. The team's experience with the famed V-2 rocket of World War II is clearly evident in many features of the *Redstone*.

Redstone is equipped with a liquid propellant rocket engine, developing 75,000-lb thrust burning liquid oxygen and alcohol. Graphite vanes located in the exhaust of the rocket supply thrust control. External fins provide aerodynamic stability, once sufficient velocity has been obtained.

Redstone's guidance system is entirely self-contained. The target data, or flight program, is fed into a program device, which plays back the information to the various elements of the control system that guide the missile in flight.

The missile has been designed so that it may be transported by air, rail or truck. It is later assembled and fired in the field. Production of the operational model of the *Redstone* is the responsibility of Chrysler.

DESIGNATION:	XSSM-A-14
PRIME CONTRACTOR:	Chrysler
STATUS:	Production, service use
RANGE:	180-250 miles
FRAME	
Manufacturer:	Reynolds Metal Co.
Length (Overall), ft:	62
Diameter (Body), ft:	5.5
Span, ft:	12
Weight (Gross), lb:	45,000
Material (Major):	Aluminum
GUIDANCE	
Manufacturer:	Ford Instrument Co.
Type:	Inertial
POWER PLANT	
Manufacturer:	Rocketdyne
Propellants:	Liquid oxygen and alcohol
Type & Number:	Regenerative cooled (1)
Thrust, lb:	75,000
WARHEAD	
Type:	Nuclear capability (warhead separates)
GROUND SUPPORT MAJOR CONTRACTORS	
Fueling:	Air Products



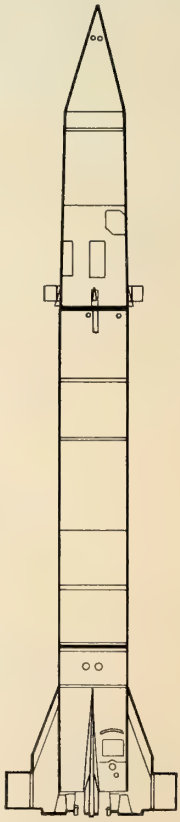
Army

REDSTONE **in the gantry for final checks.**



Army

FROST covers lower portion of *Redstone.*



SERGEANT

The *Sergeant* medium range guided missile is the latest addition to the Army's missile family. It will succeed the four-year-old *Corporal* and will incorporate improvements over the *Corporal's* power, range and accuracy.

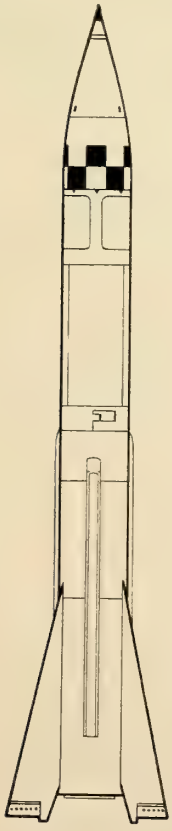
Sergeant's inertial guidance system is invulnerable to any known means of countermeasures. It uses a solid-propellant rocket, developed and produced by Tiokol Chemical Corp.

A highly mobile weapon, *Sergeant* can be quickly emplaced and fired under all weather conditions. The use of solid propellant and the inertial guidance have minimized system maintenance requirements and simplified ground handling procedures and equipment. The missile is launched in a near vertical position from an erector-launcher. All system elements have been designed for portability and mobility, and are transportable by air and standard Army vehicles.

The *Sergeant* system was designed and developed by the Jet Propulsion Lab of CIT. Production of the weapon system, including erector-launcher, servicing, handling and maintenance equipment, will be the responsibility of Sperry Rand Corp. Sperry received the prime contract for production of the missile system early in 1956. Production of the missile is currently underway at Sperry's Salt Lake City manufacturing facilities.

DESIGNATION:	FAGMS-S
PRIME CONTRACTOR:	JPL/Sperry Gyroscope
STATUS:	Development, production
RANGE:	100+

FRAME	
Manufacturer:	Sperry
Length (Overall), ft:	30
Diameter (Body), ft:	3
Span, ft:	7.7
Weight (Gross), lb:	20-25,000
Material (Major):	Aluminum and steel
GUIDANCE	
Manufacturer:	Sperry/Minneapolis-Honeywell
Type:	Inertial
POWER PLANT	
Manufacturer:	Thiokol
Propellants:	Solid
Type & Number:	Cast Polysulfide (1)
Thrust, lb:	50,000+
WARHEAD	
Type:	Nuclear capability
GROUND SUPPORT MAJOR CONTRACTORS	
Launcher:	Sperry
Radar & Ground Control:	Sperry
Handling & Service:	GFE
Transport Vehicles:	GFE
Check Out Equipment:	Sperry





Army

Sergeant **ready to fire on launcher.**



Army

Corporal's **successor roars upward**

U.S. ARMY



THE ARMY HAS demonstrated the tactical striking power of the helicopter, wedded to the rocket powered missile. This is an approach that will gain increasing favor with the Army and the Marine Corps. The helicopter also has proved its value in transporting tactical missiles from one site to another.

U.S. ARMY—Missiles of the Future

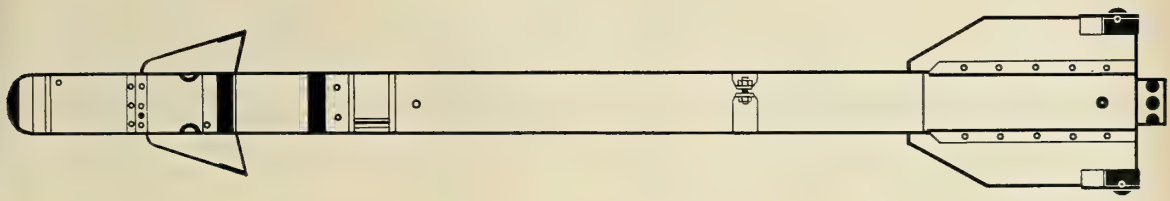
NIKE-ZEUS

Nike-Zeus is an anti-ballistic-missile missile system that can also be used against bombers. It has reached an advanced stage of development. One of the most critical factors has been detecting, which will utilize electromagnetic disturbances as the attacking missile re-enters and accelerates down through the atmosphere to impact. Overall system includes rocket-powered missile, electro-acoustical detection (for first warning), acquisition and missile trackering radar. Bell Telephone Laboratories has prime research and development responsibility; Western Electric, prime systems; Douglas, the missile. Over a quarter of a billion dollars of fiscal 1959 funds are allocated for *Nike-Zeus*.

PERSHING

Pershing is an over-500-mile range ballistic missile being developed for extended tactical surface-to-surface missions by the Army. It employs a nuclear warhead. While *Sergeant* replaces *Corporal* and *Redstone*, *Pershing*, in fact, extends the Army's range. Martin-Orlando has prime systems responsibility, while Thiokol will make the solid rocket propulsion system and Bendix, the guidance. The *Pershing* test vehicle will have a 30-ft. long by 2-ft. diameter first stage, with the second stage being somewhat shorter—like a stretched out but thinner *Polaris*. It will probably carry a one-megaton warhead. In terms of money, it is believed that Army has already scheduled about $1 billion for its development and initial production.

SIDEWINDER



The Navy's *Sidewinder* is a rugged, inexpensive, homing missile. It is capable of operating against high-performance aircraft, and can destroy enemy fighters or bombers from sea level to altitudes over 50,000 ft.

Sidewinder has less than two dozen moving parts, and no more electronic components than an ordinary radio. It does not need complex launching equipment, and is highly maneuverable at supersonic speeds. Specialized training is not required to handle and assemble the missile effectively.

The missile has a General Electric infra-red system and homes on radiation from its target. However, its performance is hindered by cloud formations due to the infra-red system. Basically designed as a defensive weapon for naval warfare, it will also be used in the air defense of the U.S.

The guidance system is passive infra-red, which usually takes the missile up the tail pipe of the target aircraft. The seeker occupies the first four inches of the missile, followed by the guidance section. The servo motors are located between the forward fins, followed by the warhead.

The missile is 4½ in. in diameter and 9 ft. long. The motor is 75 in. long, with a nozzle 7 in. in length.

Sidewinder's seeker is operative from the moment of the launcher aircraft's takeoff. Range at high altitude is 11,000 feet, and at sea level about 3,500 feet.

DESIGNATION:	AAM-N-7
PRIME CONTRACTOR:	Philco, GE
STATUS:	Production, service use
RANGE:	6-7 miles
VELOCITY:	Mach 2.5
FRAME	
Manufacturer:	Hunter-Douglas, Norris Thermador
Length (Overall), ft:	9.5
Diameter (Body), ft:	.42
Span, ft:	2
Weight (Gross), lb:	55
Material (Major):	Aluminum
GUIDANCE	
Manufacturer:	Philco Corp.
Type:	Infra-red homing
POWER PLANT	
Manufacturer:	Hercules Powder
Propellants:	Solid
Type & Number:	Uncooled, cast (1)
WARHEAD	
Type:	High explosive
GROUND SUPPORT MAJOR CONTRACTORS	
Radar & Ground Control:	Philco
Handling & Service:	Beatrice Field Tank Co.
Check-Out Equipment:	Philco



Navy

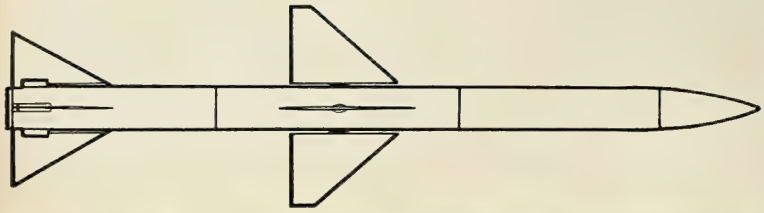
MODEL of the *Sidewinder* missile.



USAF

CHANGES in the most recent model.

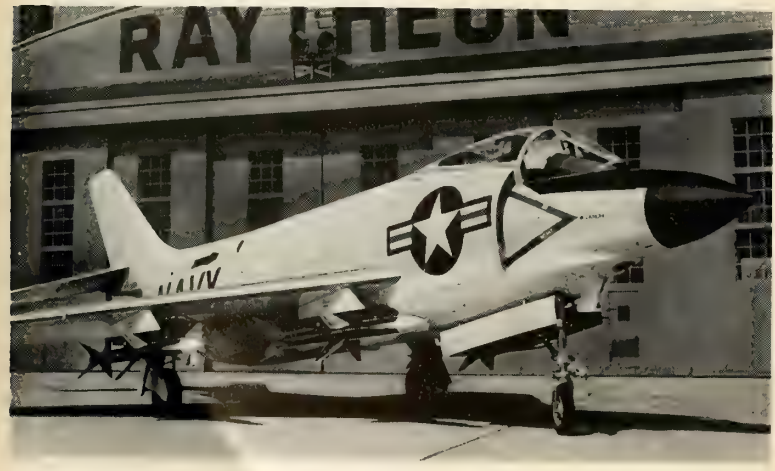
SPARROW III





Howard Levy

ADVANCE OVER EARLY MODEL, missile attains immediate 1,000 mph speed.



Navy

MOST ADVANCED missile of kind is claim for *Sparrow* III.

Sparrow III was the first air-to-air guided missile in this country. The *Sparrow* I version, now obsolete, was developed by the Bureau of Aeronautics at the Naval Air Missile Test center and the Sperry Gyroscope Co.

The *Sparrow* I, and *Sparrow* III, are launched by carrier based fighters. The weapons system is versatile and permits effective attacks against high and low altitude targets flying alone or in groups.

Guidance signals deflect the wings of the missile, and direct interception to the objective, even under evasive action. Guidance is by radar homing, and is directed in the first seconds of flight by launching aircraft.

The Navy's *Sparrow* III is an advancement over *Sparrow* I. It attains a speed of over 1,000 mph immediately after launching. The Raytheon guidance system is said to be completely automatic in operation.

Sparrow III is the most advanced missile of its kind. It is intended to be used extensively by Navy fighter aircraft in Fleet air defense. *Sparrow* III is in the group of externally-slung, aircraft-launched missiles that are subject to temperature limitations which may limit the operational performance of their launching aircraft. The problem is aerodynamic heating, and the possibility of premature, explosive ignition of the propellant charge.

DESIGNATION:	AAM-N-6
PRIME CONTRACTOR:	Raytheon
STATUS:	Production
RANGE:	5-8 miles
VELOCITY:	Mach. 2.5-3
FRAME	
Manufacturer:	Raytheon
Length (Overall), ft:	12
Diameter (Body), ft:	.75 (approx.)
Span, ft:	3.25 (approx.)
Weight (Gross), lb:	350
Material (Major):	Aluminum and magnesium
GUIDANCE	
Manufacturer:	Raytheon
Type:	Radar homing
POWER PLANT	
Manufacturer:	Aerojet General
Propellants:	Solid
Type & Number:	Uncooled, cast (1)
WARHEAD	
Type:	High explosive
GROUND SUPPORT MAJOR CONTRACTORS	
Handling & Service:	Elgin National Watch Co.

ZUNI

The Navy's *Zuni* is an air-to-air rocket designed for fighter and attack-type aircraft. It is under development by the Naval Ordnance Test Station for the Bureau of Ordnance. *Zuni* has jet-operated folding fins, a feature that allows an aircraft to carry four times as many rockets.

Zuni will be effective against tanks, pillboxes and other hard-to-destroy emplacements. Its high velocity and short-time-to-target assures it as a high-kill potential in air-to-air combat. The launcher, mounted on the aircraft's wing, holds four rockets and is used for transporting and storing, as well as launching. Launchers are jettisoned after firing.

The *Zuni* carries a variety of warheads and fuse systems. It will be used for both air-to-air and air-to-surface firing.

The disadvantage of this type of weapon is that it is an aimed rocket rather than a guided missile. However, this concept has certain advantages, not the least of which is a minimum of "bugs"; it is simply constructed; can be produced and fired in volume at a low cost and to the limit of its abilities; is not only flexible as to operational deployment, but is available now. Even today, in the age of the highly complex guided (and therefore jammable) missile, it is a mainstay of weaponry.



Navy

MISSILE is compact for easy carry on fighter aircraft.



Navy

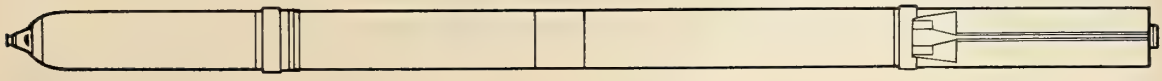
TANKS, PILLBOXES are among targets for *Zuni*.

PRIME CONTRACTOR:	NOTS
STATUS:	Production
RANGE:	5 miles max.
VELOCITY:	Mach 3
FRAME	
Manufacturer:	Hunter-Douglas
Length (Overall), ft:	9.17
Diameter (Body), ft:	0.42
Weight (Gross), lb:	107
Material (Major):	Aluminum
GUIDANCE	
Type:	Unguided
POWER PLANT	
Propellants:	Solid
Type & Number:	Cast (1)—4 nozzles
WARHEAD	
Type:	High explosive



Navy

FOLDING FINS make possible bigger load for plane.

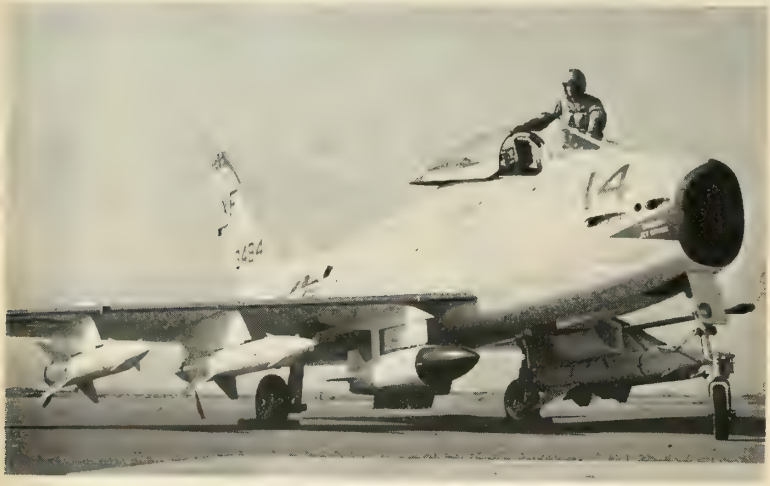


BULLPUP



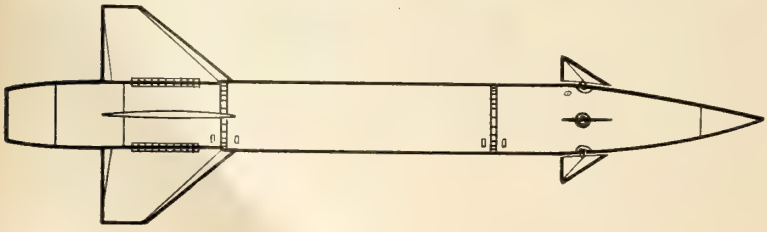
Navy

BEING FITTED into wing holders, *Bullpup* shows size.



Navy

POWERFUL WEAPONS multiply armament of Navy plane.



The Navy's *Bullpup* is the first air-to-ground missile especially designed to provide non-nuclear fire support to ground troops and tactical targets. It is designed to practically eliminate the usual ground support system of maintenance and training.

Bullpup can carry a variety of 250 lbs. of bombs. It is a supersonic solid-propellant missile.

The missile is controlled by direction button in the cockpit of the firing aircraft. The control gives up-down and right-left commands. The pilot, by flying the aircraft, simultaneously flies the missile until it is zeroed-in on the target.

Because of the simplicity of the *Bullpup*, it can be checked out at the factory, placed in storage up to six months and have its three parts assembled and mounted on an aircraft in five minutes by a three-man crew. It has been said that this bird has "eyeball" guidance, but regardless of these witticisms, the *Bullpup* is one of the first of a long upcoming series of vitally important tactical missiles designed to minimize the roll of and danger to manned aircraft.

DESIGNATION:	ASM-N-7
PRIME CONTRACTOR:	Martin
STATUS:	Production
RANGE:	5 miles (approx.)
VELOCITY:	Mach 1-2
FRAME	
Manufacturer:	Martin
Length (Overall), ft:	11
Diameter (Body), ft:	1
Span, ft:	2.7 (approx.)
Weight (Gross), lb:	540
Material (Major):	Aluminum
GUIDANCE	
Manufacturer:	Martin
Type:	Visual reference radio command
POWER PLANT	
Manufacturer:	Allegheny Ballistics
Propellants:	Solid
Type & Number	Cast, uncooled (1)
WARHEAD	
Type:	250-pound bombs

RAT

Rat is one of the Navy's rocket assisted torpedos. It is launched from destroyers in pursuit of enemy subs, and is expected to be in fleet operation by the end of this year.

Developed by the Naval Ordnance Test station, the *Rat* weapon system consists of standard homing torpedo, solid-propellant rocket booster and detachable aerodynamic control surfaces for stability.

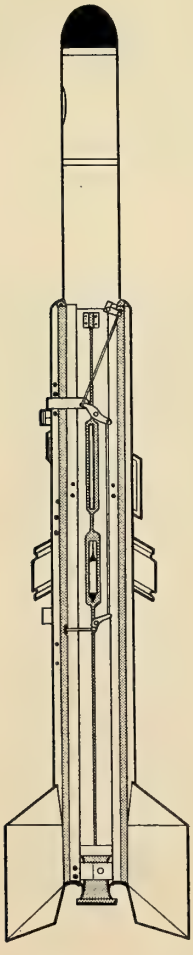
The destroyer's sonar equipment detects and tracks the enemy submarine. Then the ship's fire-control system elevates the *Rat* launcher and sets the range. The rocket motor propels the torpedo along a ballistic flight path and separates as it reenters the water where the parachutes and nose cape are discarded. *Rat* then starts a circling search pattern until the homing device makes contact and guides the weapon to its target.

The *Rat* may also be air launched.

Rat is the first of a long line of such anti-submarine weapons, such as *Subroc*, a more sophisticated follow-on.

PRIME CONTRACTOR	NOTS
STATUS:	Production
RANGE:	5 miles

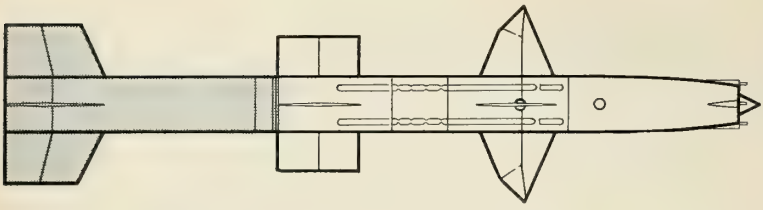
FRAME	
Stages:	2
Manufacturer:	NOTS
Length (Overall), ft:	16
Diameter (Body), ft:	1.28 (approx.)
Span, ft:	2.5 (approx.)
Weight (Gross), lb:	450
Material (Major):	Steel
GUIDANCE	
Manufacturer:	NOTS
Type:	Acoustical
POWER PLANTS	
First Stage (Booster)	
Manufacturer:	Allegheny Ballistics
Propellants:	Solid
Type & Number:	Cast, uncooled (1)
Second Stage	
Type & Number:	Homing Torpedo (1)
WARHEAD	
Type:	Standard Torpedo





MISSILE IS TORPEDO-LAUNCHED from destroyer at subs.

TALOS



Talos, a Navy supersonic guided missile, is designed to destroy enemy aircraft at a range of more than 65 miles and at extreme altitudes.

The *Talos* will form the major armament of the light cruiser Galveston, and plans are underway to equip the first nuclear-powered U.S. cruiser with the system.

The surface-to-air missile is accelerated to supersonic flight by a solid propellant rocket. The booster is jettisoned after the missile reaches cruising speed. The ram-jet sustainer then ignites, and provides thrust to keep the missile at a constant speed throughout its flight. A two-stage guidance system gives *Talos* the capability of high firepower, as well as accuracy at long ranges. The first stage carries the missile from launcher to target area; it is then taken over by a beam-riding guidance system.

Talos is now being produced under a $27-million contract for the Navy by the missile section of the Bendix Aviation Corp. Its development began with the *Bumblebee* program, under the direction of the Applied Physics Lab of Johns Hopkins University.

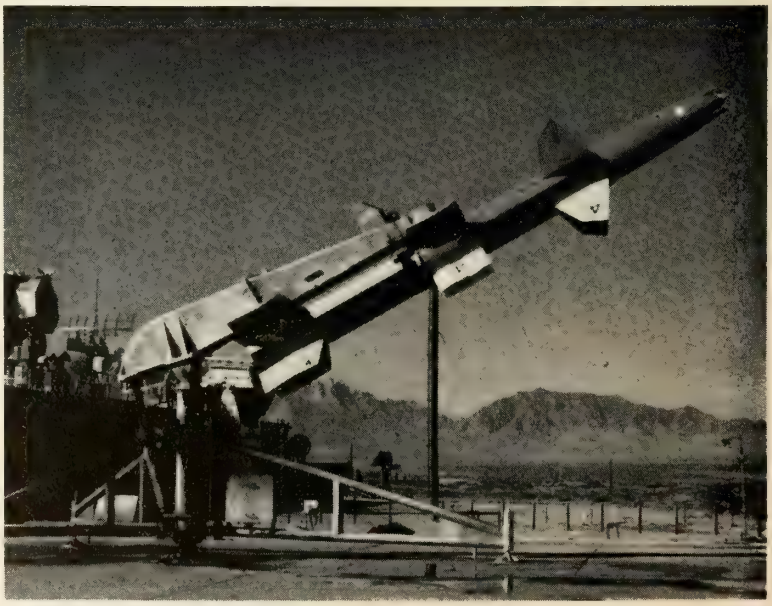
By 1960, *Talos* will be installed aboard four other cruisers of the Navy, in addition to the Galveston. Army deployment of the *Talos* is still uncertain, although there are indications that it will be phased out before it becomes operational.

DESIGNATION:	SAM-N-6
PRIME CONTRACTOR:	Bendix, RCA
STATUS:	Production
RANGE:	70 miles (approx.)
VELOCITY:	Mach 3+
FRAME	
Manufacturer:	McDonnell
Length (Overall), ft:	20 (booster 10 ft. approx.)
Diameter (Body), ft:	2.5
Span, ft:	9.48
Weight (Gross), lb:	3000 (less booster)
Material (Major):	Steel
GUIDANCE	
Manufacturer:	Farnsworth Electronics, Sperry
Type:	Beam Rider/passive homing
POWER PLANTS	
First Stage (Booster)	
Manufacturer:	Bendix
Propellants:	Solid
Type & Number:	Cast (1)
Second Stage	
Manufacturer:	McDonnell
Propellants:	JP
Type & Number:	18" ramjet (1)
WARHEAD	
Type:	High explosive or nuclear
GROUND SUPPORT MAJOR CONTRACTORS	
Launcher:	GE, RCA, American Machine & Foundry, North Ordnance
Radar & Ground Control:	RCA
Handling & Serv.:	GE, Northern Ordnance



Bendix

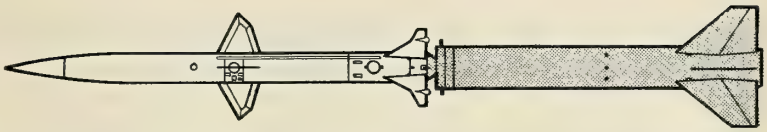
GALVESTON is first *Talos* cruiser.



Navy

***TALOS* AT LAND-BASED installation of the Naval Ordnance Missile Test Facility.**

TERRIER I & II



The Navy's *Terrier*, a supersonic surface-to-air missile, was fired experimentally in November, 1954, from the USS Mississippi. It is designed to intercept aircraft under all weather conditions at longer range and higher altitudes than anti-aircraft guns.

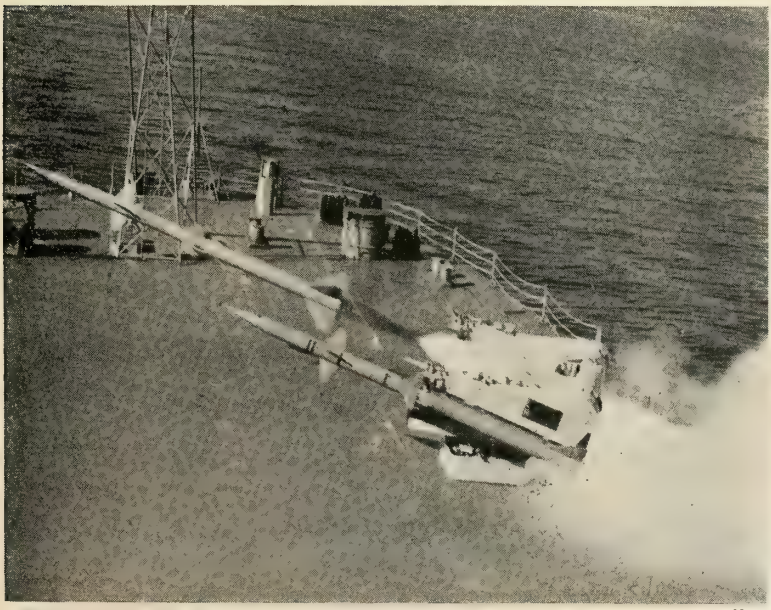
Terrier I is installed on the cruisers USS Boston, USS Canberra, destroyer USS Gyatt, and will be used on many other destroyer-frigate-type vessels. The solid-propellant power-plant is produced by Allegheny Ballistic. *Terrier* I is booster-launched, and travels to the target by beam-rider guidance.

Terrier II is reported to be larger than *Terrier* I, and will have radar homing guidance to supplement ship-board beam-rider direction. It will also be launched by a booster.

The *Terrier* is being produced in quantity for the U.S. Navy Bureau of Ordnance at the government-owned Naval Industrial Reserve Ordnance Plant, operated for the Navy by Convair.

Each *Terrier* launcher is served by its own magazine and missile over-haul and servicing room. The missiles and their boosters are stored vertically in a ready service ring, one for each arm of the two-missile launcher. The missile is selected, positioned, loaded and placed on its launching rail in a matter of seconds.

DESIGNATION:	SAM-N-7 (I)
PRIME CONTRACTOR:	Convair
STATUS:	Production, service use
RANGE:	10 miles max. (No. I), 20 miles max. (No. II)
VELOCITY:	Mach 2.5 max.
FRAME	
Stages:	2
Manufacturer:	Convair
Length (Overall), ft:	15 ft. (No. I), 27 with booster
Diameter (Body), ft:	1 (approx.)
Span, ft:	3.5 (approx.)
Weight (Gross), lb:	1000 launching wt. (No. I)
GUIDANCE	
Manufacturer:	Reeves/FTL (No. I) Sperry (No. II)
Type:	Beam rider
POWER PLANTS	
First Stage (Booster)	
Manufacturer:	Allegheny Ballistics The Hicks Co.
Propellants:	Solid
Type & Number:	Uncooled, cast (1)
Second Stage	
Manufacturer:	Allegheny Ballistics
Propellants:	Solid
Type & Number:	Uncooled, cast (1)
WARHEAD	
Type:	High explosive
GROUND SUPPORT MAJOR CONTRACTORS	
Launcher:	Northern Ord.
Radar & Ground Control:	Sperry Gyro, Western Elec., Reeves Instr.
Handling & Service:	Baker-Raulang, Wash. Tech. Associates
Transport Vehicles:	Baker-Raulang



Navy

EARLY TEST VERSION of *Terrier* leaving launcher aboard U.S.S. Norton Sound.



Convair

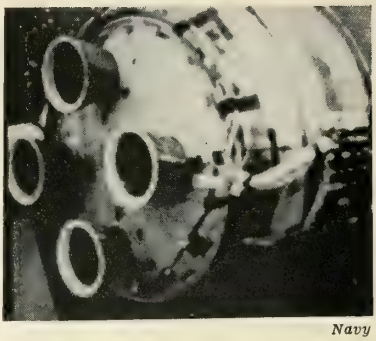
***TERRIERS* ON AFT DECK of Canberra.**

POLARIS

The Navy first announced plans for the *Polaris* Fleet Ballistic Missile early in 1957. The missile is now rated "top priority" by the Navy, and will be the Navy's first intermediate range ballistic missile. *Polaris* is designed to fire from surface ships, as well as submarines in under-water positions.

Due to refinement of design, *Polaris* will be smaller and lighter than other IRBMs. It will be small enough to permit carrying a sizeable number of missiles in a single sub, without increasing the size beyond present nuclear powered submarine dimensions.

The missile is carried aboard the submarine in individual containers. Compressed air in the container forces the *Polaris* to the surface of the water in torpedo fashion. The missile will be lifted to altitude and set on course by its original propulsion and guidance components. *Polaris* is capable of carrying a thermonuclear warhead.



Navy

NOZZLE END of *Polaris* first-stage motor.

PRIME CONTRACTOR:	Lockheed
STATUS:	Research and development
RANGE:	1500 miles
VELOCITY:	6000 mph (average)
FRAME	
Stages:	2
Manufacturer:	Lockheed
Length (Overall), ft:	26.5
Diameter (Body), ft:	4.5
Weight (Gross), lb:	28,000
Material (Major):	Steel
GUIDANCE	
Manufacturer:	GE/MIT, Sperry Gyro
Type:	Inertial
POWER PLANTS	
First Stage (Booster)	
Manufacturer:	Aerojet
Propellants:	Solid
Type & Number:	(1) Cast, uncooled, 4 nozzles
Thrust, lb:	80-100,000
Second Stage	
Manufacturer:	Aerojet, Thiokol
Propellants:	Solid
Type & Number:	(1) Cast, uncooled, 3 nozzles, jetavators
WARHEAD	
Type:	Nuclear
GROUND SUPPORT MAJOR CONTRACTORS	
Launcher:	Westinghouse, Sperry Gyro
Fueling:	Aerojet
Radar & Ground Control:	G.E.
Handling & Service:	Westinghouse



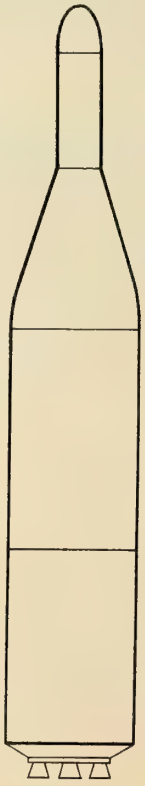
Navy

DUMMY *Polaris* in underwater tests.



Navy

EJECTION TESTS from simulated sub container.



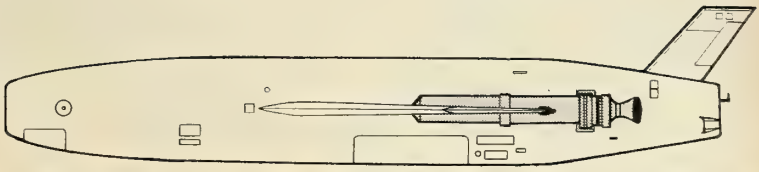
REGULUS I

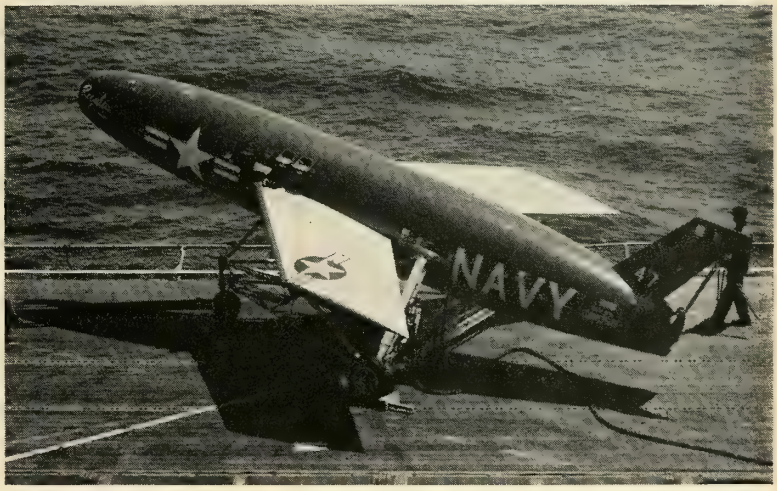
Regulus I, surface-to-surface missile was developed by Chance Vought in 1948, under the sponsorship of the Bureau of Aeronautics. It resembles a swept-wing fighter. A submarine can surface, fire the *Regulus and* submerge, all within minutes. Tactically, it will be used by Marines against appropriate land targets.

Launching equipment can be installed in a short period of time on several types of vessels, with only slight modification to the ship. The missile's wings fold for shipboard storage.

Regulus I is launched from a short rail launcher, where it rests on four slipper fittings. Launching boost is from two rockets which accelerate the *Regulus* to flying speed in a little over two seconds. Rocket cases and slippers are ejected after the launching. It is boosted to flight speed by two Aerojet solid propellant JATOs.

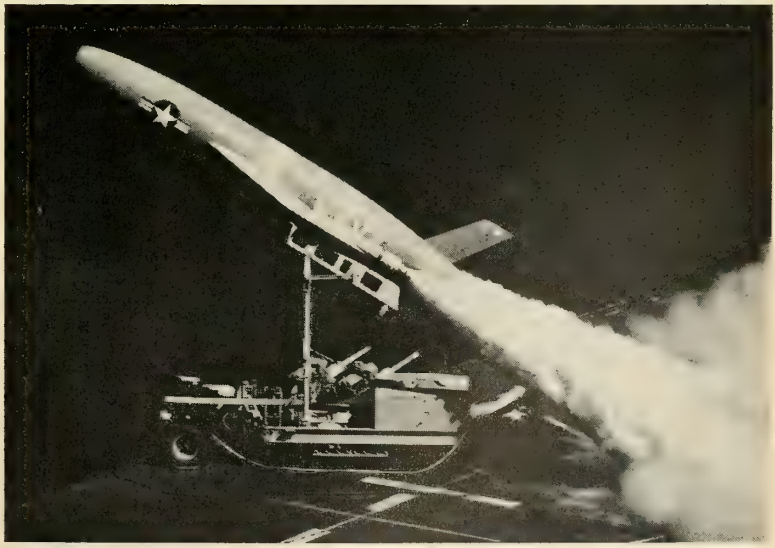
DESIGNATION:	SSM-N-8a
PRIME CONTRACTOR:	Chance Vought
STATUS:	Production, service use
RANGE:	500 miles
VELOCITY:	Mach 0.9
FRAME	
Manufacturer:	Chance Vought
Length (Overall), ft:	33
Diameter (Body), ft:	4.5
Span, ft:	21
Weight (Gross), lb:	12,000 (less booster)
Material (Major):	Aluminum
GUIDANCE	
Manufacturer:	Sperry
Type:	Command
POWER PLANTS	
First Stage (Booster)	
Manufacturer:	Aerojet
Propellants:	Solid
Type and Number:	JATO (2)
Thrust, lb:	66,000 @ 33,000
Second Stage	
Manufacturer:	Allison
Propellants:	JP
Type & Number:	Turbojet (1)
Thrust, lb:	4600
WARHEAD	
Type:	High explosive or nuclear
GROUND SUPPORT MAJOR CONTRACTORS	
Launcher:	Fruehauf, Cook Electric
Fueling:	Bowser
Radar & Ground Control:	Chance Vought, Hallamore Electronics
Handling & Service:	Airlogistics, Weber, Fruehauf, AC Spark Plugs
Transport Vehicles:	Spencer-Stafford, Fruehauf





Navy

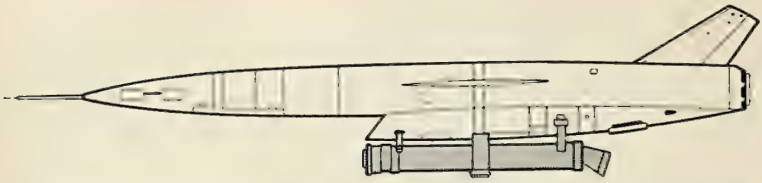
REGULUS **CAN BE launched from carrier decks with steam catapulted carts.**



Navy

A ZERO-LENGTH launch is made from deck of carrier, boosted by rocket power.

REGULUS II





Navy

LANDING GEAR permits recovery of bird after flight.



Chance Vought

REGULUS **II has faster, longer range than predecessor.**

The Navy's faster-than-sound guided missile *Regulus* II, is a faster, longer-range version of *Regulus* I. *Regulus* II is designed to be launched from submarines, aircraft carriers cruisers and shore bases.

Chance Vought Aircraft reports that *Regulus* II is "probably the most remarkable 'Bird' now under development."

Regulus II has a General Electric turbojet J79 engine, and is capable of delivering a nuclear warhead with "pinpoint" accuracy to a target more than 1,000 miles away, at twice the speed of sound and at altitudes over 60,000 ft.

Test and training versions of *Regulus* II are equipped with landing gear so that the missiles can be recovered after each flight. *Regulus* II is a logical outgrowth of *Regulus* I, a subsonic, 1000-mile (with extra tanks) submarine-launched bird, now operational with the fleet.

DESIGNATION:	SSM-N-9a
PRIME CONTRACTOR:	Chance Vought
STATUS:	Development production
RANGE:	1000 miles
VELOCITY:	Mach 2
FRAME	
Manufacturer:	Chance Vought
Length (Overall), ft:	57
Diameter (Body), ft:	6
Span, ft:	20
Weight (Gross), lb:	22,000 (less booster)
Material (Major):	Aluminum
GUIDANCE	
Manufacturer:	AC Electronics
Type:	Command or inertial
POWER PLANTS	
First Stage (Booster)	
Manufacturer:	Aerojet
Propellants:	Solid
Type & Number:	JATO (1)
Thrust, lb:	100,000 (approx.)
Second Stage	
Manufacturer:	GE
Propellants:	JP
Type & Number::	J79 turbojet (1)
Thrust, lb:	15,000
WARHEAD	
Type:	Nuclear
GROUND SUPPORT MAJOR CONTRACTORS	
Launcher:	Fruehauf, Cook Electric
Fueling:	Bowser
Radar & Ground Control:	Chance Vought
Handling & Service:	Airlogistics, Weber, Fruehauf, AC Spark Plug
Transport Vehicles:	Spencer Stafford, Fruehauf

ASROC

Anti-Submarine Rocket, or—some say—Atomic-Submarine-Rocket. Launched underwater, the Asroc covers most of its distance through the air and then re-enters the water to seek its target by acoustical homing. Produced by the Minneapolis-Honeywell Co. which also has the systems responsibility.

ASTOR

Anti-Submarine Torpedo Ordnance Rocket. In development now by Westinghouse Ordnance, Baltimore, *Astor* is based on a vehicle the size of a Mark 18 torpedo. Nuclear warhead gives it a large kill radius when used as a supersubmarine killer. It is one of several such underwater atomic capabilities being developed by the Navy.

CORVUS

Corvus is an air-to-surface missile being developed by Temco under a multi-million dollar Navy contract. The missile would be used on carrier and shore-based aircraft of Navy and Marine Corps. Texas Instrument and W. L. Maxon are developing guidance, Reaction Motors reportedly is developing power plant.

CROSSBOW

Crossbow is an air-to-surface missile under development by Northrop, powered by a turbo-jet which will give it a velocity of about 500 knots. It homes on enemy radar. This makes it, in effect, an enemy defense degradation missile, designed to either silence or keep silent enemy radar.

DIAMONDBACK

Diamondback is an air-to-air missile believed to be a successor to the infra-red homing *Sidewinder*, and reportedly is under development by Naval Ordnance Test Station, China Lake, Calif. Basically, it will have increased range and performance over *Sidewinder* and Navy may fit it with "liquid-packaged" propellant. Philco is prime.

EAGLE

Still in the proposal and cross-proposal stage, the *Eagle* is rumored to be a "highly sophisticated" missile scheduled to be married to a simple fighter plane which will act only as a platform. Range is 50-100 miles and projected use is for both air-to-ground and air-to-air.

EX-8

EX-8 is an Aerojet-General project designed to give the Navy an ultra-high speed underwater anti-submarine missile. It is designated as a rocket (or perhaps hydro-duct) powered torpedo with speeds up to and perhaps exceeding 150 knots. Reportedly a new method of cavitation control has been developed to decrease drag and noise.

HOPI

Hopi is another Navy missile in the advanced development stage. Supposed to be capable of carrying a hydrogen warhead (minimum weight on the order of 650 pounds), *Hopi* is a medium-range air-to-surface missile being developed by the Naval Ordnance Test Station at Inyokern, Calif., designed for carrier aircraft.

KATIE

Katie, like *Subroc*, is a weapons system aimed at extending the useful life of conventional naval ships now in service. *Katie* is reported to be a rocket with a nuclear fission warhead that will be capable of utilizing regular 16-inch guns on Navy ships as launching tubes. Presumably it would be both surface-to-surface and anti-submarine.

RAVEN

An air-to-surface missile, one of many the Navy is currently working on. Unique feature is the hot-gas generator propulsion system. No other details have been revealed. However, it is rumored that this missile will also be launched by a comparatively simple fighter plane.

SUBROC

A missile designed to be launched from conventional torpedo tubes. Fired underwater, but flies most of its (25-50 mile) course through the air. Reported to have a nuclear capability. Goodyear is the prime contractor with Librascope and Kearfott companies listed as major sub-contractors.

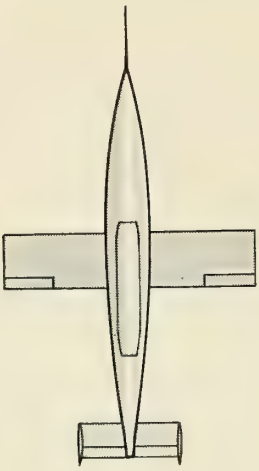
TARTAR

Similar to the *Terrier*, but smaller, the *Tartar* is carried by cruisers and destroyers. After launch, the missile is a beam-rider. The radar beam can reportedly handle more than one missile at a time. Speed is in excess of Mach 2. Convair-Pomona has prime systems responsibility.

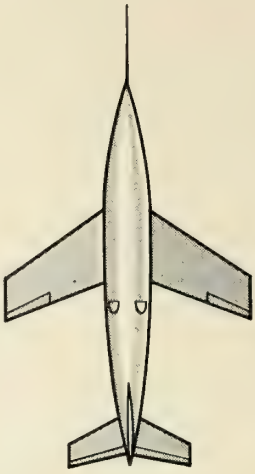
MISSILES of the U.S.S.R.



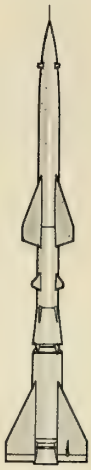
M-100A



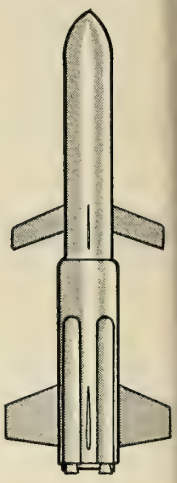
J-2



J-3



M-2



T-6

Air to Air

M-100A

The United States became familiar with the M-100A air-to-air missile during the conflict in Korea where it was first placed in service.

In the same class as the *Falcon*, this weapon is of a very primitive design. It features a single solid rocket, and can be used with infrared guidance or unguided.

STATUS:	Operational production
RANGE:	3.4 miles
VELOCITY:	1740 mph
FRAME	
Length (Overall), ft:	4.43
Diameter (Body), ft:	0.26
Span, ft:	0.82
Weight (Gross), lb:	18.5
GUIDANCE	
Type:	Infrared (also unguided.)
POWER PLANT	
Propellants:	Solid
Number	1
Thrust, lb:	100
Exhaust velocity:	1000 ft/sec.
Burning time:	3.1 sec.

Anti-Submarine

J-2

The J-2 air-breathing missile is similar to the *Snark*. Three versions of the missile are reported to be in the R&D stage.

In addition to its mission as a submarine weapon the J-2 can be equipped with containers to carry about 3,200 lbs. of supplies to isolated troop units.

The third J-2 version features landing skids for recovery purposes. The peak & ceiling is estimated at 6.8 miles.

STATUS:	Research and development
RANGE:	525 miles
VELOCITY:	645 mph
FRAME	
Stages:	2
Length (Overall), ft:	36.6
Span, ft:	23.6
Weight (Gross), lb:	16,100
GUIDANCE	
Type:	Radio
POWER PLANTS	
First Stage (Booster)	
Propellants:	Solid
Type & Number:	2
Second Stage	
Propellants:	Kerosene
Type & Number:	Axial-flow turbine (1)
Thrust, lb:	4850
WARHEAD	
Weight, lb:	2200

J-3

This weapon, designed for use against marine targets is a supersonic version of the J-2 and features the same fuselage and guidance instrumentation.

The main differences are the swept-back wings and the addition of a ramjet and two booster rockets. Being ramp-launched, the J-3 has a peak ceiling of 10.25 miles.

STATUS:	Trial production
RANGE:	450 miles
VELOCITY:	875 mph max.
FRAME	
Stages:	2
Length (Overall), ft:	38.25
Span, ft:	23.6
Weight (Gross), lb:	18,700
GUIDANCE	
Type:	Radio or radar
First Stage (Booster)	
Propellants:	Solid
Type & Number:	4
Second Stage	
Propellants:	Kerosene
Type & Number:	Axial-flow turbine and ramjet
Thrust, lb:	15,000
WARHEAD	
Weight, lb:	2200

Surface to Air

M-2

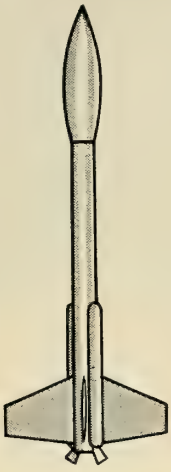
The M-2 two-stage guided missile, intended for surface-to-air and surface-to-surface purposes, was developed from the German *Rheintochter*.

Already in service, this weapon is launched from mobile units.

STATUS:	Operational production



T-7



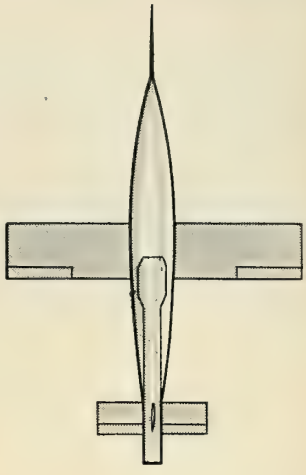
T-8



COMET 1 (CH-17)



COMET 2 (CH-18)



J-1

RANGE:	37.25 miles (Ceiling: 13.5-15.5 miles)
VELOCITY:	1550 mph
FRAME	
Stages:	2
Length (Overall), ft:	25
Diameter (Body), ft:	1.64
Span, ft:	9.9
Weight (Gross), lb:	3970
GUIDANCE	
Type:	Radar and infrared
POWER PLANTS	
First Stage (Booster)	
Propellants:	Solid
Number:	1
Thrust, lb:	9,350
Second Stage	
Propellants:	Solid
Number:	1
Thrust, lb:	4,625
WARHEAD	
Weight, lb:	22-26.5

T-6

A surface-to-air missile of the *Nike* class, this weapon is reputed to be highly efficient for air defense. It has four boosters in addition to the sustainer propulsion unit—and has an operational ceiling of about 60,000 feet. The high-explosive warhead is armed with a proximity fuze.

STATUS:	Operational
VELOCITY:	1630 mph
FRAME	
Stages:	2
Length (Overall), ft:	22
Diameter (Body), ft:	2.8
Span, ft:	7.9
Weight (Gross), lb:	4000
GUIDANCE	
Type:	Radar
POWER PLANTS	
First Stage (Booster)	
Propellants:	Solid
Number:	4
Thrust, lb:	10,000
Second Stage	
Propellants:	Solid
Number:	2
Thrust, lb:	1,100
WARHEAD	
Weight, lb:	88

T-7

The T-7 was originally developed by the USSR Academy of Sciences as a high altitude research vehicle, and has been adapted to military use. Its range is not available, but its peak altitude during flight is approximately 60 miles. Guidance is reported to be inertial.

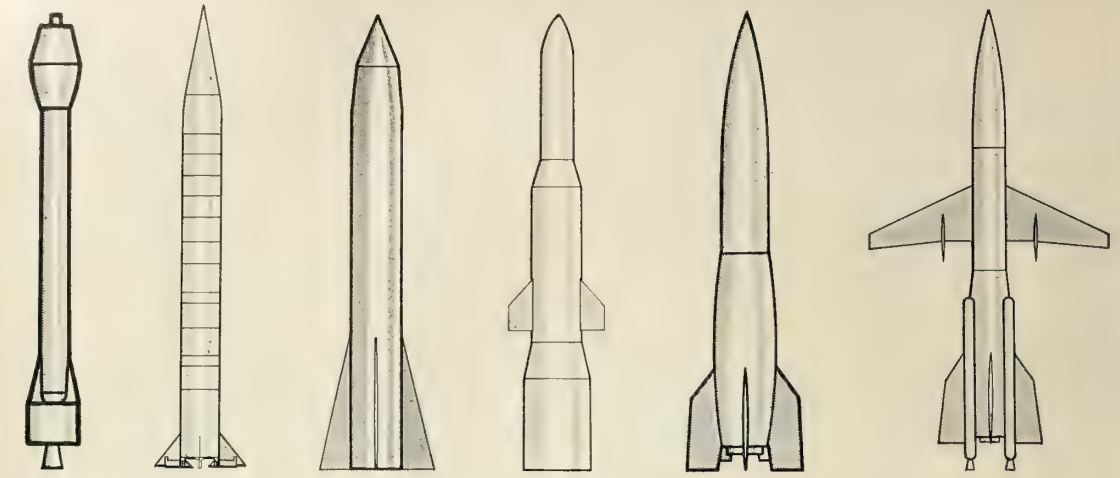
STATUS:	Operational
VELOCITY:	3350 mph
FRAME	
Length (Overall), ft:	30
Diameter (Body), ft:	2.7
Span, ft:	9.2
Weight (Gross), lb:	5,050
POWER PLANT	
Propellants:	Liquid oxygen and hydrazine
Type & Number:	LPR
Thrust, lb:	11,000
WARHEAD	
Weight, lb:	18

T-8

The best anti-aircraft missile in the Soviet Union, this infrared-guided missile is a single-stage vehicle utilizing boosters for initial acceleration. The missile is highly maneuverable in the air and highly mobile on the ground, being used by field batteries from non-permanent positions. Its high-explosive warhead is armed with a proximity fuze.

The T-8 has been in use for several years and is used in the defense of most Soviet cities. Other rockets in this category are the T-6 and the GVAI, both being rough counterparts of the *Nike-Ajax* surface-to-air missile.

STATUS:	Operational
RANGE:	15 miles
VELOCITY:	1450 mph
FRAME	
Stages:	2
Length (Overall), ft:	13.2
Diameter (Body), ft:	1.05
Span, ft:	4.8
Weight (Gross), lb:	1875
GUIDANCE	
Type:	Infrared
POWER PLANTS	
First Stage (Booster)	
Propellants:	Solid
Number:	2
Second Stage	
Propellants:	Nitric acid/alcohol
Number:	1
Thrust, lb:	4600
WARHEAD	
Weight, lb:	4.9



Surface to Surface

COMET 1 (CH-17)

Originally designed as a research vehicle for studies of the *Comet* 2 re-entry problem, *Comet* 1 performed so well that it was put in production and subsequently placed in service.

This single-stage, solid-propellant missile has a burning time of 18 sec., a maximum ceiling of about 42 miles, and a thrust-to-weight ratio of 2.63.

STATUS:	Operational production
RANGE:	75-100 miles
VELOCITY:	3225 mph.
FRAME	
Length (Overall), ft:	36.8
Diameter (Body), ft:	4.26
Span, ft:	10.9
Weight (Gross), lb:	20,000
POWER PLANT	
Propellants:	Solid
Thrust, lb:	53,250
Exhaust Velocity:	9200 ft/sec
WARHEAD	
Weight, lb:	460

COMET 2 (CH-18)

This missile's exterior is in general identical to that of *Comet* 1. The only apparent difference is in the longer cone of *Comet* 2 due to the larger warhead.

With a thrust-to-weight ratio of 2.4 *Comet* 2 reaches peak height at 195 miles. The power plant is a solid propellant version of the German A-9 with a burning time of 115 sec.

It has been reported that the USSR has a production of approximately 3200 *Comet* 2 missiles per month.

STATUS:	Production; being readied for service.
RANGE:	620 miles
VELOCITY:	5700 mph
FRAME	
Length (Overall), ft:	43.4
Diameter (Body), ft:	4.26
Span, ft:	10.9
Weight (Gross), lb:	41,500
GUIDANCE	
Type:	Inertial
POWER PLANT	
Propellants:	Solid
Thrust, lb:	99,000
Exhaust velocity:	9500 ft/sec
WARHEAD	
Weight, lbs:	550

J-1

The J-1 medium-distance, low-level, guided attack weapon is to a large degree a continuation of the German V-1.

It can be launched from either runway or sled and has a peak ceiling of approximately 4 miles. Low-level flight is made possible through equipment within the missile designed to cut out detection radar.

STATUS:	Operational production
RANGE:	370 miles



Sovfoto

THE SOVIET T-1, AN IMPROVED GERMAN V-2, mainstay of the SSM program.



Sovfoto

GRAPHITE VANES JUTTING INTO THE EXHAUST STREAM of the T-1 indicate technique of gimballed motors not used.

VELOCITY:	519 mph
FRAME	
Length (Overall), ft:	26.9
Span, ft:	20.7
Weight (Gross), lb:	9700
GUIDANCE	
Type:	Radio
POWER PLANTS	
First Stage (Booster)	
Propellants:	Solid
Number:	2
Second Stage	
Propellants:	Kerosene
Type & Number:	Pulsejet (1)
Thrust, lb:	2000
WARHEAD	
Weight, lb:	2640

ME (IGOR)

This anti-tank missile is to a certain degree comparable to the U.S. *Bazooka*, and it uses the same type launching system.

The ME, however, has a longer range, but it is doubtful whether this is of significance in anti-tank warfare. It is difficult to make a hit with a *Bazooka* at distances above 900-1000 ft.

STATUS:	Operational production
RANGE:	2.25 miles
RANGE:	
VELOCITY:	535 mph
FRAME	
Length (Overall), ft:	4
Diameter (Body), ft:	0.41
Weight (Gross), lb:	10.5
POWER PLANT	
First Stage	
Propellants:	Solid
Type & Number:	Sulphur-base 1
Thrust, lb:	61.5
Exhaust velocity:	9250 ft/sec.
Burning time:	3 sec.
WARHEAD	
Weight, lb:	3.75

T-1 (M-101)

An almost-exact copy of the German V-2 (A-4) missile, this vehicle has a greatly increased range due to structural and fuel improvements. The T-1 is as mobile as our *Redstone*, and is equipped with a self-propelled launcher and support vehicles. The T-1 configuration follows a straight cylinder design, whereas the V-2 was more elliptical. The change is due to the easier production of the cylinder sections. This missile is the basic design from which the longer range T-2 was developed, and is reported to be the third stage of the intercontinental T-3. There is considerable conjecture that *Sputnik* II consisted of an entire T-1 rocket placed in orbit, but contradictory evidence prevents any conclusion on this speculation.

STATUS:	Operational
RANGE:	400-600 miles
VELOCITY:	4400 mph
FRAME	
Length (Overall), ft:	50-52 ft
Diameter (Body), ft:	5.15
Span, ft:	12
Weight (Gross), lb:	38,000
GUIDANCE	
Type:	Radio-inertial
POWER PLANT	
Propellants:	Oxygen/alcohol
Thrust, lb:	77,000-78,000
WARHEAD	
Weight, lb:	2,650
Type:	Nuclear

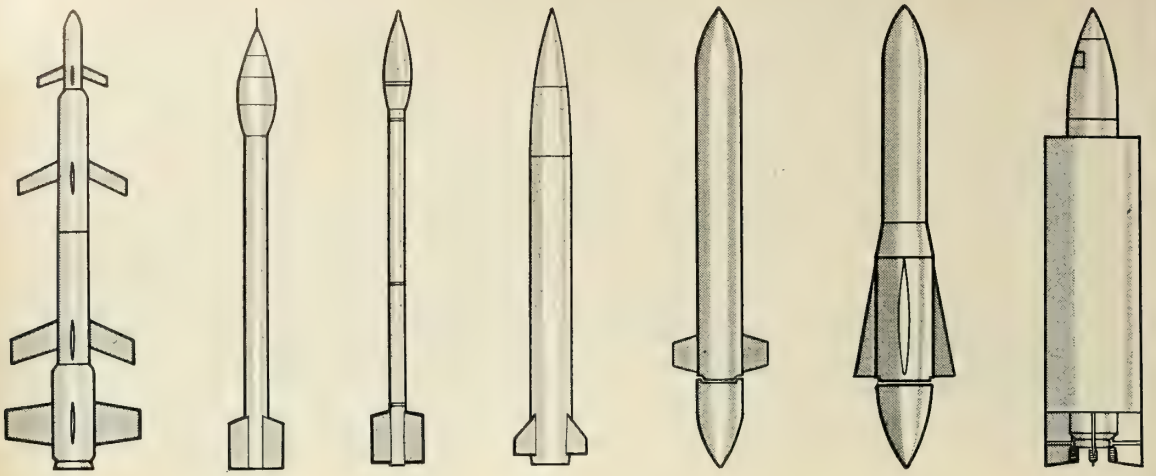
T-2 (M-103)

The most operational of Soviet long-range missiles, the T-2 is the first two-stage missile in the USSR's arsenal. It has been deployed throughout Europe at various bases, and reportedly has been concentrated along the southern flank of the satellite countries in order to cover the U.S. airbases in North Africa and Spain where SAC operates. Other T-2 launching sites are located so as to reach most of western Europe. There is little doubt that this missile is a continuation of the T-1 program, which sprang from the German V-2 missile and was greatly improved upon by the Russians.

STATUS:	Operational
RANGE:	1800 miles
VELOCITY:	5200 mph
FRAME	
Stages:	2
Length (Overall), ft:	90-100
Diameter (Body), ft:	12-15
Span, ft:	27
Weight (Gross), lb:	122,000
GUIDANCE	
Type:	Radio-inertial
POWER PLANTS	
First Stage (Booster)	
Propellants:	Oxygen/alcohol
Thrust, lb:	254,000-270,000
Second Stage	
Propellants:	Oxygen/alcohol
Thrust, lb:	77,000-78,000
WARHEAD	
Weight, lb:	2450
Type:	Nuclear

T-3 (M-104)

This missile was first reported successfully fired in August, 1957. Also designated M-104, the missile has a reported accuracy of ±10 miles from a given point. The second and third stages are understood to be modified



T-1 and T-2 missiles, thus simplifying development programs and allowing the maximum mileage from a minimum of hardware and logistical support items. The T-3 is probably the Soviet missile showing the least German influence on its design.

It has a good mass ratio, and is adaptable to mass production without the setting up of a complex system of precision operations. Guidance is in the second stage. The missile is quite likely to be the basic unit for the satellite-launching vehicle utilized by the USSR.

STATUS:	Development production
RANGE:	5000 miles
VELOCITY:	15,000 mph
FRAME	
Stages:	3
Length (Overall), ft:	110-125
Diameter (Body), ft:	16
Span, ft:	23.5
Weight (Gross), lb:	165,000-175,000
GUIDANCE	
Type:	Radio-inertial
POWER PLANTS	
First Stage	
Propellants:	Oxygen/kerosene
Number:	1-2
Thrust, lb:	490,000-500,000
Second Stage	
Propellants:	Oxygen/kerosene
Number:	
Thrust, lb:	270,000
WARHEAD	
Weight, lb:	2200
Type:	Nuclear

T-3A

A follow-on program of the T-3, this missile has an increased range but decreased payload capability. Two versions of the T-3A have been reported.

STATUS:	Development production
RANGE:	6200 miles
VELOCITY:	16,000 mph
FRAME	
Stages:	3
Length (Overall), ft:	112
Diameter (Body), ft:	16
Span, ft:	23.5
Weight (Gross), lb:	185,000
GUIDANCE	
Type:	Radio-inertial
POWER PLANTS	
First Stage	
Propellants:	Liquid oxygen/kerosene
Number:	1-2
Thrust, lb:	520,000
Second Stage	
Propellants:	Liquid oxygen/kerosene
Number:	1
Thrust, lb:	270,000
WARHEAD	
Weight, lb:	1200 (approx.)
Type:	Nuclear

T-4 (M-102)

This medium range ballistic missile is reported to have excellent guidance, but at the sake of high efficiency levels for the overall vehicle. It will deliver an 1,800-pound atomic warhead to a target with great accuracy, and can be fired from relatively mobile field equipment—as our *Redstone* or the German V-2 missiles.

STATUS:	Production
RANGE:	1000 miles
VELOCITY:	9500 mph
FRAME	
Stages:	2
Length (Overall), ft:	50-55
Diameter (Body), ft:	6.6
Span, ft:	14
Weight (Gross), lb:	71,000
GUIDANCE	
Type:	Radio-inertial
POWER PLANTS	
First Stage (Booster)	
Propellants:	Oxygen/hydrazine
Number:	1
Thrust, lb:	182,000
Second Stage	
Propellants:	Oxygen/hydrazine
Number:	1
Thrust, lb:	53,000
WARHEAD	
Weight, lb:	1775
Type:	Nuclear

T-4A

This is a Soviet version of the Saenger-Bredt antipodal boost-glide skip bomber, and its presence in the Soviet arsenal prompted the U.S. to launch the Dyna-Soar project. It will quite likely be a manned vehicle, but some sources have disputed this. Stainless steel surfaces will reduce air friction and heating. A free-fall bomb or a guided missile may be utilized as armament.

After completion of a mission, the pilot may land the vehicle in the ocean and be picked up by a submarine; or, range permitting, may land in friendly territory. The idea behind this type of vehicle was first proposed as far back as the early days of World War II, but met with scepticism and was not adopted.

STATUS:	Development, preliminary testing
RANGE:	12,000 miles
VELOCITY:	14,000-15,000 mph
FRAME	
Length (Overall), ft:	120-125
Diameter (Body), ft:	10-12
Span, ft:	63.5
Weight (Gross), lb:	232,000

GUIDANCE	
Type:	Manned aircraft
WARHEAD	
Weight, lb:	3100
Type:	Nuclear

T-5

A three-stage unguided missile with a range of about 100 miles, this is essentially a copy of the German Rheinbote design. It has been supplied to East European satellite armies and is mobile—as are a great many Soviet missiles. The missile is supplied to batteries which have six launchers each. Accuracy of the missile is believed to be quite good, but the type of warhead is unknown. Considering the gross weight of less than 5,000 pounds, a nuclear warhead seems unlikely, but possible.

STATUS:	Operational
RANGE:	100 miles
VELOCITY:	2900 mph
FRAME	
Stages:	4
Length (Overall), ft:	32.2
Diameter (Body), ft:	2.9
Span, ft:	9.4
Weight (Gross), lb:	4850
GUIDANCE	
Type:	Unguided
POWER PLANT	
Propellants:	Nitric acid/hydrazine (booster); SPR's (main propulsion)
Thrust, lb:	1) 83,500; 2) Unguided 3) 2,300; 4) 440

T-5B

This weapon is carried on a self-propelled launcher—a KW 85 or a Joseph Stalin II AFV tank chassis. The missile is protected during cold weather operations by a wrap-around clamshell-type heater to keep the propellant warm. According to some reports, the rocket can be elevated to firing position, alignment adjustments made, and the missile fired without a crew member leaving the armored carrier-vehicle.

STATUS:	Operational
RANGE:	25
FRAME	
Length (Overall), ft:	30
Diameter (Body), ft:	2.5
GUIDANCE	
Type:	Unguided

T-5C

This is a smaller version of the T-5B, apparently using less-temperature-sensitive propellant since the carrier vehicle is not equipped with protective heaters for the missile. It is not known whether this is a scaled-down T-5B, or whether advances in propulsion and warheads have allowed a reduction in overall size. Photos indicate that the missile is carried by a Type 1955 reconnaissance AFV chassis believed to be fully amphibious and providing full protection for the crew.

STATUS:	Operational
RANGE:	15-20 miles
FRAME	
Length (Overall), ft:	25
Diameter (Body), ft:	1-1.5 ft. (approx.)
Span, ft:	2.5-3 ft. (approx.)
Weight (Gross), lb:	4,400
GUIDANCE	
Type:	
POWER PLANT	
Propellants:	Solid
Number:	1
Thrust, lb:	
WARHEAD	
Weight, lb:	1100
Type:	High explosive or nuclear

T-7A

A modification of the T-7, this later version is rapidly replacing the T-5, which is now obsolescent and has been placed in the hands of the East European satellites. The T-7A has the same range as the T-5—100 miles—but is more accurate and utilizes a radio-inertial guidance system. It is not known whether the USSR has succeeded in equipping this missile and the T-5 with nuclear warheads. It is supported by mobile launching equipment and may be used in the field from non-permanent installations, as was the V-2.

STATUS:	Operational
RANGE:	100 miles
VELOCITY:	3200 mph
FRAME	
Length (Overall), ft:	27.8
Diameter (Body), ft:	2.7
Span, ft:	9.6



Sovfoto

HONEST JOHN'S COUNTERPART IS THE T-5B, an unguided rocket on a tracked tank chassis.



Sovfoto

A SMALLER VERSION IS THE T-5C, also on a tracked chassis, but lighter.

Weight (Gross), lb:	4,500
GUIDANCE	
Type:	Radio-inertial
POWER PLANT	
Propellants:	Liquid oxygen and hydrazine
Number:	1
Thrust, lb:	11,500
WARHEAD	
Weight, lb:	177

Weight (Gross), lb:	33.125
GUIDANCE	
Type:	Radio-inertial
POWER PLANT	
Propellants:	Liquid oxygen and alcohol
Type & Number:	1
Thrust, lb:	121,200
Exhaust velocity:	8000 ft/sec.
Burning time:	65 sec.
WARHEAD	
Weight, lb:	1750-2000

Propellants:	Nitric acid and alcohol
Thrust, lb:	242,000
Second Stage	
Propellants:	Nitric acid and alcohol
Thrust, lb:	71,500
Total burning time:	185 sec.
Exhaust velocity:	10350 ft/sec.
WARHEAD	
Weight, lb:	1430

Underwater to Surface

GOLEM-1

The *Golem*-1 underwater-to-surface missile is transported in tow by submarines. On arrival at launching site, a chamber at the tail of the missile is filled with water to insure vertical positioning. This chamber breaks away shortly after the missile emerges from the water and is in flight.

Peak ceiling is 142 miles. It is assumed that a large number of the USSR submarine-fleet, which includes more than 600 vessels, is rigged to handle the *Golem*-1. The missile is capable of carrying an atomic warhead.

STATUS:	Operational production
RANGE:	400 miles
VELOCITY:	5425 mph
FRAME	
Length (Overall), ft:	54
Diameter (Body), ft:	5.41
Span, ft:	11.1

GOLEM-2

The *Golem*-2, which is reported to be the underwater version of the T-2 IRBM, is still in the R&D stage.

The major difference is in the propellant used for both stages, i.e., *Golem*-2 uses a nitric acid-alcohol combination, while T-2 is propelled by liquid oxygen and alcohol. It is assumed that this change was incorporated for the purpose of increasing the storage capacity of the underwater version. Peak ceiling is 244 miles.

STATUS:	Research and development
RANGE:	1240 miles
VELOCITY:	9325 mph
FRAME	
Stages:	2
Length (Overall), ft:	57
Diameter (Body), ft:	7.2
Span, ft:	13.1
Weight (Gross), lb:	75,000
GUIDANCE	
Type:	Radio-inertial
POWER PLANTS	
First Stage (Booster)	

Underwater to Air

GOLEM-3

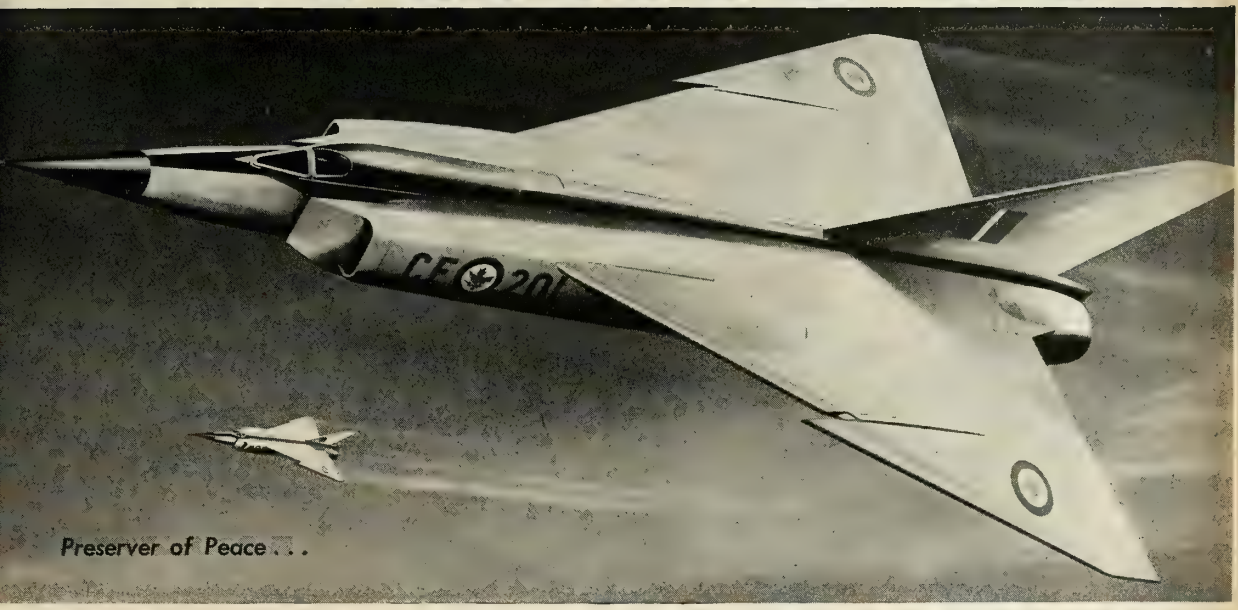
The *Golem*-3 is a solid propellant anti-aircraft missile designed to be launched from either a submarine or a mobile battery. Reportedly, this weapon can be launched from depths of approximately 650 ft.

STATUS:	Operational production
RANGE:	7.45 miles
VELOCITY:	1860 mph
FRAME	
Length (Overall), ft:	17.1
Diameter (Body), ft:	2.14
Span, ft:	5.9
Weight (Gross), lb:	4625
GUIDANCE	
Type:	Infrared
POWER PLANT	
Propellants:	Solid
Type & Number:	4
Thrust, lb:	15,000
Exhaust velocity:	10,000 ft/sec.
Burning time:	8.2 sec.
WARHEAD	
Weight, lb:	175



THE OVERRIDING CHARACTERISTIC OF MOBILITY is shown in every photo of Soviet missiles, as demonstrated by the T-7A.

AVRO ARROW



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RCA

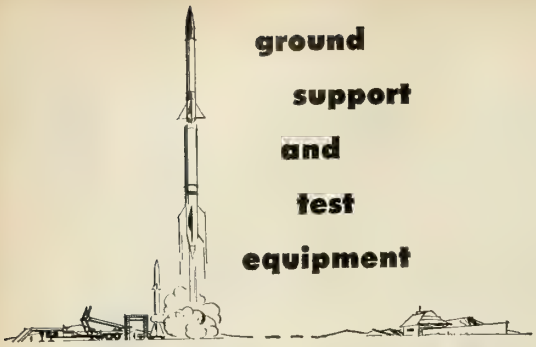
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DEFENSE ELECTRONIC PRODUCTS

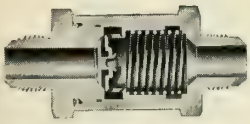
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ground support and test equipment

REPUBLIC VALVES

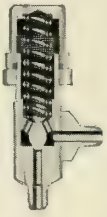


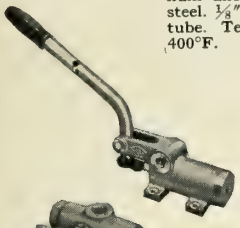
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No leakage. 3000 psi. Very low pressure drop. Can be furnished to open at ¼ to 35 psi. Brass, stainless steel, or aluminum alloy. ⅛" to 2" pipe or tube. Temp. range -65° to 200°F.

RELIEF VALVES

Quick unloading, smooth operation. Guided shut-off piston with stainless steel or Nylon seat. Pressure range to 4000 psi. Brass, aluminum alloy, or stainless steel. ⅛" to ¾" pipe or tube. Temp. range to 400°F.





HAND PUMP

For hydraulic applications on missile carrier and support equipment. Double-acting. 2 cu. in. displacement per cycle. 1000 psi. working pressure. Aluminum alloy body, stainless steel trim. -65° to 160°F.



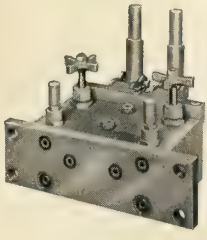
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For automatically maintaining height and level condition in any vehicle with air spring suspension. Controls swaying in transit, and off-level position while standing. Applicable to trucks, buses, trailers, carriers, cranes, etc.

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Smooth, easy operation, with low turning torque because of pressure balancing design. 0 to 6000 psi. Bronze, steel, or aluminum alloy. ⅛" to 2" pipe or tube. 2, 3, 4 ports.





DUAL HAND PUMP

2 pumps, 2 relief valves, and 2 needle shut-off valves, compactly manifolded for elevating mechanisms, hydraulic applications on ground support equipment, etc. Aluminum alloy body, stainless steel trim. -65° to 160°F.

Distributors in principal cities coast to coast



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RM REPUBLIC MANUFACTURING CO.

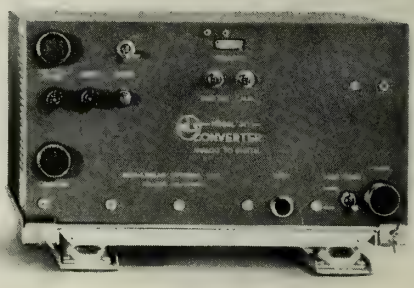
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Are dry circuits your problem?

If so, we believe we have the answer. Dry-circuit reliability and long life are outstanding features of the Syncroverter high-speed relay. It's unaffected during severe shock and vibration. It has fast pull-in and drop-out and negligible contact resistance, and it operates reliably over a wide temperature range.

More than 20 models available

You can specify Bristol Syncroverter high-speed relays in an extremely wide variety of operating characteristics and in various case and mounting arrangements. Ask us for complete details. Write: The Bristol Company, 173 Bristol Road, Waterbury 20, Conn. 8.3A

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BRISTOL FINE PRECISION INSTRUMENTS FOR OVER 68 YEARS

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Electronics Contract Awarded to Sylvania

Receipt of a $2.63 million contract award from the U.S. Army Signal Research & Development Lab., Ft. Monmouth, N.J., for a "continuation of development work in electronics" has been announced by Sylvania Electric Products, Inc.

Sylvania reported that the award is a continuation of a research and development contract originally awarded six years ago, which has been renewed on an annual basis. Work on the contract is being carried out at the company's Electronic Defense Laboratory.

Electronic Circuit Package Facilities Now Available

The "packaging" of electronic circuits, from schematic diagram to the final printed circuit or modular form, has become a highly specialized part of product design. Space restrictions, temperature, shock and vibration requirements are often severe.

The potentialities and limitations of the printed circuit process, and its many modular forms, present their own problems. Proper "packaging" can reduce manufacturing cost and greatly increase reliability.

An engineering service, covering this phase of electronic design, has been inaugurated by Arthur Ansley Mfg. Co., New Hope, Pa. The company has reported that printed circuit manufacturing facilities are available for making prototype boards to test the final design.

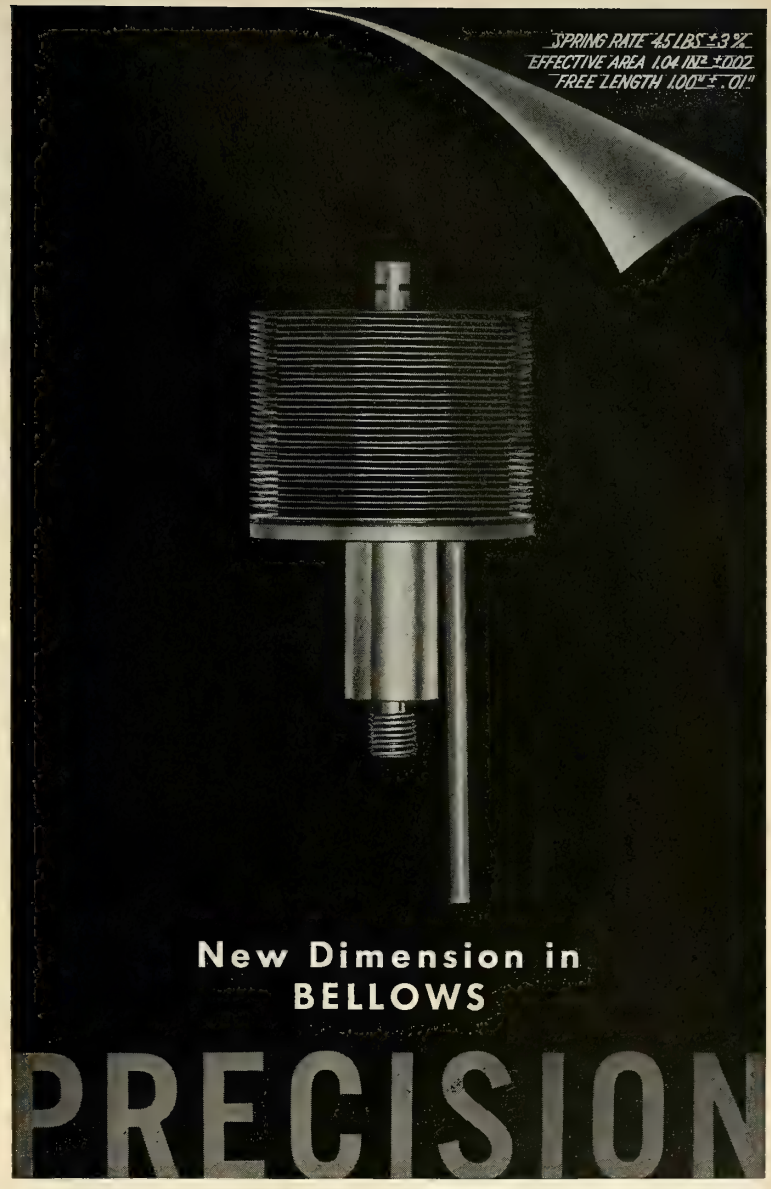
STL Missile Symposium Investigates AF Program

Scientific and technical experts in the field of ballistic missiles from the nation's leading universities, research laboratories and industrial firms attended the Third Annual Ballistic Missile Symposium held recently at the Ramo-Wooldridge Space Technology Laboratories, Los Angeles.

During the two-day classified meeting, the missile experts attended special scientific sessions and exchanged information through the presentations of technical papers on major aspects of the Air Force Ballistic Missile Program.

Co-hosts for the event were Maj. Gen. B. A. Schriever, commander of the Ballistic Missile Division, Air Research and Development Command, USAF; and Dr. Ruben Mettler, vice president of STL.

Among the organizations represented were: Massachusetts Institute of Technology, AC Spark Plug, Lockheed



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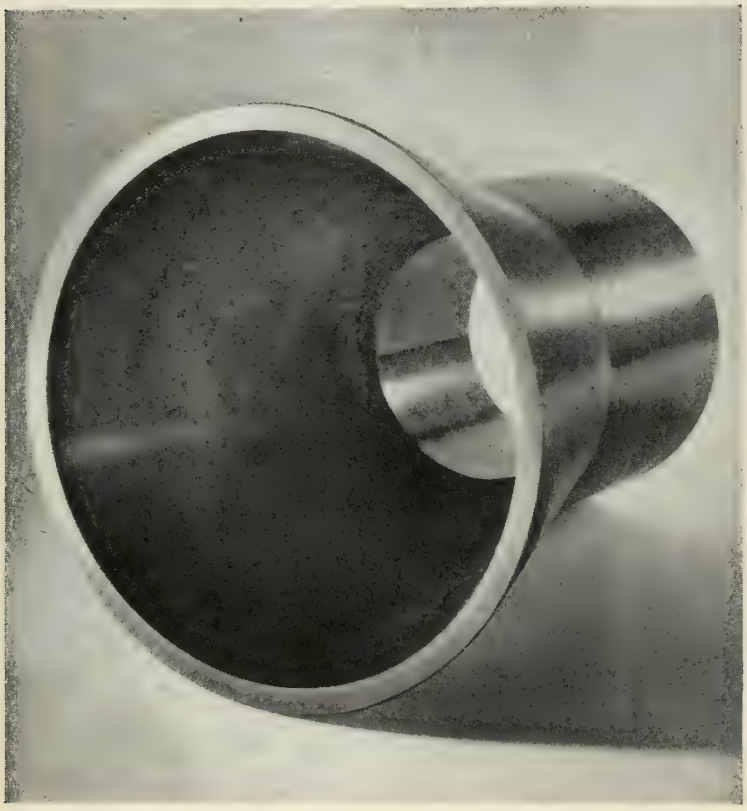
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The rocket exhaust throat shown here is an example of what these important new R/M materials can do for you. They provide exceptionally high strength-to-weight ratios, take a smooth finish, and can be mass produced to precision standards. Other missile parts for which R/M Pyrotex has been selected: nose and exhaust cones, blast tubes, grain seats, fins and combustion chamber liners. If heat extremes are part of your problem, it will pay you to get more details on R/M Pyrotex!

For further information, write for technical bulletin

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Aircraft, General Electric, Martin Co., Burroughs Corp., Scientific Advisory Committee, Scientific Advisory Board, Avco Manuf., University of Michigan, Aero-jet General, Convair, Bell Telephone Labs, Douglas Aircraft, Remington Rand, American Machine and Foundry.

Joint sponsors of the symposium were the Ballistic Missile Division, the Ballistic Missile Office, Air Materiel Command, USAF; and STL.

May Transistor Sales Close To 3 Million Units

Factory sales of transistors during the month of May amounted to 2.99 million units, with a dollar value of $7,250 million. This is an increase of 142,964 units and $225,277 over the sales figures for April 1958, and 944,-198 units worth $1,614 million over the figures for May 1957.

The sales report, issued by Electronics Industries Association, also indicates that the cumulative sales of transistors during the first five months of this year increased substantially over the same period in 1957. Sales figures for the period January through May 1958 totaled 14,894 million units valued at $34,582 million, compared with 8,954 million transistors with a value of $25,128 million sold during the same period last year.

The EIA chart below shows factory sales and dollar values for the January-May period of 1958. The unit figures for the corresponding months of 1957 are included for comparison purposes.

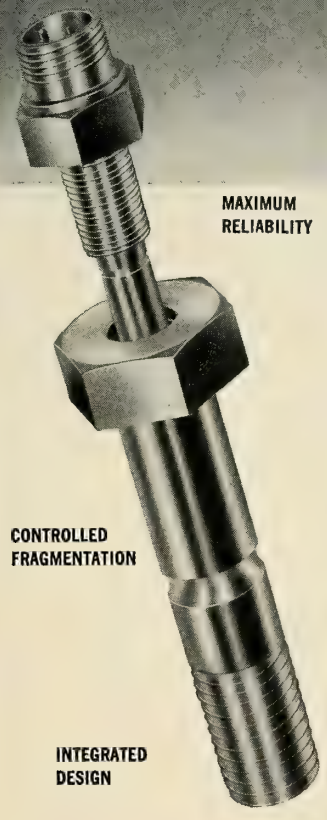
	1958 Sales (units)	1958 Sales (dollars)	1957 Sales (units)
January	2,955,247	$6,704,383	1,436,000
February	3,106,708	6,806,562	1,785,000
March	2,976,843	6,795,427	1,904,000
April	2,856,234	7,025,547	1,774,000
May	2,999,198	7,250,824	2,055,000
TOTAL	14,894,230	$34,582,743	8,954,000

Magnavox Forms New Subsidiary

Magnavox Co. of Ft. Wayne, Inc., has announced the formation of a new subsidiary—Magnavox Astro-Physics Laboratories, Inc., which is to be located in Rochester, N.Y. The initial efforts of the company will be under the direction of Col. James W. Anderson, Jr., (USAF-ret), who was connected with Rome Air Development Center until November, 1957. The new subsidiary was formed to meet future defense needs in the field of missile and space technology.

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W. Coast Co. to Develop Missile Electronic Systems

Formation of a new subsidiary company for the development of ground and airborne electronic equipment for missiles and space vehicles has been announced by Pacific Automation Products, Inc., Glendale, California, manufacturers of engineered cable systems for missiles and missile bases.

The new organization—Space Electronics Corp.—is headed by Dr. J. C. Fletcher and Frank W. Lehan, formerly director and assistant director respectively of the Electronics Laboratory of the Ramo-Wooldridge Corp.

Before joining R-W, Dr. Fletcher was head of the System Laboratory of the Guided Missile Division at Hughes Aircraft Co. He is president of the new company.

Lehan was formerly chief of the Electronics Research Section of Jet Propulsion Laboratory.

In addition to developing electronics subsystems for missile and space programs, Dr. Fletcher said the new company would conduct research into electronic techniques generally applicable to space vehicles, but which are not yet ready to be intergrated into a system.

The president of Pacific Automation Products, Inc., Frank G. Jameson, said that SEC will be affiliated with the parent company in some joint enterprises, but in most cases will work independently.

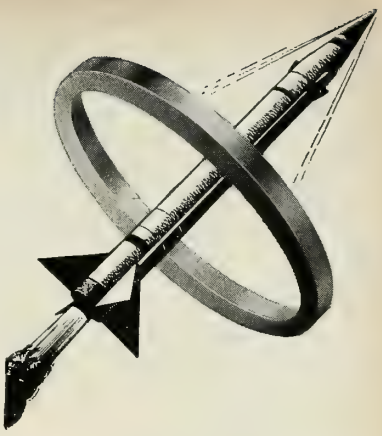
The biographical material released in connection with the formation of the new organization describes Dr. Fletcher and Lehan as having been responsible for development of the guidance and control systems for all missiles in the Air Force Ballistic Missile Program, including the solid propellant *Minuteman*.

Nike Communication System Planned for Alaska

A contract for installation of two inter-battery microwave communication systems between *Nike* missile sites and anti-aircraft operation centers (AAOC) in Alaska has been awarded to Philco Corporation's Government and Industrial Division.

The $1,050 million contract, awarded by the U.S. Army Engineer District Alaska, which performs construction for the Army and Air Force in Alaska, also calls for one year's maintenance of the system from completion date of the project.

The communications system was planned and designed by the Headquarters Signal Office, U.S. Army



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Help to Withstand High Temperatures . . . A jet engine shaft seal of Kentanium,* a titanium carbide, operating without lubrication at 15,000 surface feet per minute at 1000°F and 0.6 pounds pressure per lineal inch of circumference outperformed every other material tried. Kentanium is stress-free, dimensionally stable, maintains great strength and provides exceptional resistance to abrasion. It is providing all of these advantages on many applications . . . at temperatures up to 2000°F and as high as 5000°F for momentary service.

Help Solvent Separators to Resist Abrasion . . . On this job, Kennametal rings of Grade K96 were installed, replacing conventional seals which had at no time given more than two months' service and had sometimes failed in only 30 hours. Kennametal rings were inspected after six months in service, showed no perceptible wear and were returned to service. The customer predicts an ultimate service advantage of 50 to 1.

Help to Power Rockets . . . Here the sealing rings are used to handle red fuming nitric acid. After extensive testing of materials, rings made of Kennametal K501, a platinum-base composition, were chosen. The manufacturer reports: "Kennametal ring sealing results have been far superior to any other material with no indication of seal face wear." This was after the best life of the rings previously used had been exceeded.

For details, write for 24-page Booklet B-111, "Characteristics of Kennametal" . . . and 12-page Booklet B-444 which describes "Kentanium." KENNAMETAL INC., Dept. MR, Latrobe, Pa.

*Trademark 3172

INDUSTRY AND KENNAMETAL ...Partners in Progress

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Alaska, with engineering assistance from the Army Signal Engineering Agency in Washington.

One microwave system will consist of a four-station hook-up of *Nike* sites in the Fort Richardson-Elmendorf Air Force Base area and the AAOC on Fire Island near Anchorage.

The other six-station communication system will connect the *Nike* batteries guarding the Ladd AFB-Eielson AFB area with the AAOC at Murphy Dome near Fairbanks.

This microwave equipment, which operates in the 6,000 to 8,000 megacycle frequency range, will be equipped with full automatic standby transmitter and receiver units, automatic switching devices and suitable alarms. It also is equipped with a duplexing tee for transmitting and receiving on the same antenna.

All antennas in the Alaska *Nike* microwave system will be equipped with heated plastic covers to keep them free of snow and ice. The covers also will protect the antenna feed horn from rain, dust and condensation.

The CLR-9 uses "heat sinks" instead of blowers to cool the klystrons, eliminating extensive blower maintenance and klystron failures caused by faulty blowers.

In the tubeless power supply, vacuum tubes have been replaced with new semi-conductor rectifiers which provide long life potential and cooler operation of the power supply.

Operational *Nike* missile battalions in Alaska are part of air defense under control of the Alaska Command.

IT&T Establishes New Space Lab

International Telephone and Telegraph Corp. has established a new space laboratory at Fort Wayne, Ind. for systems research and development. Main work will be on guidance and control, data processing and instrumentation of space vehicles.

Projects under study include: a radio relay system using a number of "fixed" satellites for world-wide dial telephoning and television transmission; an interplanetary navigation system for manned space ships; space-to-earth communication systems using compressed radio bandwidths.

Donald M. Culler has been named head of the new astronics lab. The staff will be augmented by a consulting group of scientists from midwestern universities, according to Henri Busignies, IT&T Laboratories president.

Pressurization Units for Guidance Systems

Two new pressurization units for use in missile guidance systems have been developed by Eastern Industries, Inc.

Model E/AP 100, Type 202, provides circulation of pressurized and dehydrated air to the wave guide of a radar system within a missile. The second unit, Model PRD 50, Type 100, is designed for use in tracking and guidance of ground-based missile operating controls.

The model for use in missiles is a single-cylinder compressor and motor assembly, a pressure relief valve and a DP-600 Type 100 dehydrator mounted on a common base. Total weight is 4 and ¾ lbs and delivers 150 cu. in. per minute and maintains a system pressure of 25 psi minimum.

The ground-based unit features a built-in stand-by with automatic change-controls. Dehydration is achieved through the use of dual cascade refrigeration systems.

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book reviews

WAR—1974, by Lt. Col. Robert B. Rigg, USA 304 pp., $5, The Military Service Publishing Co., Harrisburg, Pa.

This is a dramatic, action-packed account of a future global war. The book is fiction, but is by no means fantasy. The story is based on known facts, on weapons now being used by our armed forces, plus machines of warfare on the drawing boards or undergoing tests.

The book is packed with episodes ranging from hidden struggles below the earth in secret missile bases to electronic combat and undersea warfare with strange drone craft. All of this action takes place on future battlegrounds.

NONLINEAR CONTROL SYSTEMS by Robert L. Cosgriff, 328 pp., $9, McGraw-Hill, New York

This book is another in McGraw-Hill's series on Control System Engineering. The book aims to provide the control engineer with those methods of nonlinear systems which are practical in the control field.

The selection of material is such that an extensive background is not required. Only those methods and techniques which are practical from an engineering standpoint have been included, and all mathematics beyond calculus is developed in the book.

Emphasis is placed on nonlinear theory and nonlinear equations. All important points are illustrated by examples, and the book includes a short, concise treatment of linear theory.

The material is arranged to proceed from the simple to the complex, and the author has made use of the concepts and terminology of automatic-control theory rather than those of classical mechanics.

CONFERENCE ON EXTREMELY HIGH TEMPERATURES edited by Heinz Fischer and Lawerence C. Mansur, 275 pp. $9.75, John Wiley & Sons, Inc., New York.

Based on the Conference on Extremely High Temperatures held in 1958, this book is a summary of the underlying basis for commercial or usable thermonuclear reactions. Emphasis is on high temperatures as they relate to the propulsion fields, with lesser emphasis on the physics of the topics covered.

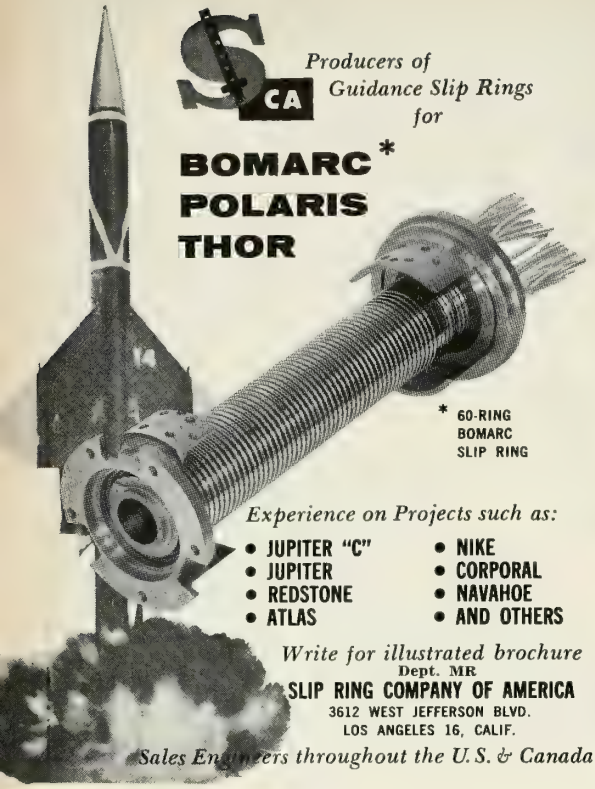
The conference was held under the sponsorship of the Air Force Cambridge Research Center, Electronics Research Directorate.



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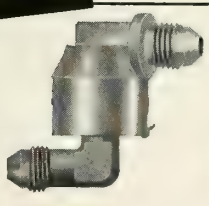
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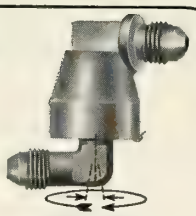
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AUGUST

ARS, IAS, Regional Technical Meeting, "Space Exploration", San Diego, Calif., Aug. 5-6.

American Institute of Electrical Engineers, Special Technical Conference on Non-Linear Magnetics and Magnetic Amplifiers, Hotel Statler, Los Angeles, Calif., Aug. 6-8.

American Society for Quality Control Annual Conference, Western Region, El Cortez Hotel, San Diego, Calif., Aug. 7-8.

Continuation Course, Modern Development in Heat Transfer, University of Minnesota, Minneapolis, Minn., Aug. 7-15.

AIEE, IRE, NBS, Conference on Electronic Standards and Measurements, National Bureau of Standards Boulder Laboratories, Boulder, Colo., Aug. 13-15.

Industrial Applications of X-Ray Analysis, Seventh Annual Conference, Albany Hotel, Denver, Colo., Aug. 13-15.

Missiles Operations Research Engineering Seminar, Pennsylvania State University, University Park, Pa., Aug. 17-23.

AAS Annual Western Regional Meeting, Stanford University, Dinkelspeil Auditorium, Palo Alto, Calif., Aug. 18-19.

ASME, A.I. Ch.E. Conference, Northwestern University, Evanston, Ill., Aug. 18-21.

Western Electronic Show & Convention, Institute of Radio Engineers, Ambassador Hotel, Los Angeles, Calif., Aug. 19-22.

Ninth Annual Congress, International Astronautical Federation, Amsterdam, Holland, Aug. 25-30.

SEPTEMBER

Summer Program, Problems of High-Powered Radar Design, Massachusetts Institute of Technology, Cambridge, Mass. (Security clearance required.) Sept. 2-12.

1958 Cryogenic Engineering Conference, Massachusetts Institute of Technology, Cambridge, Mass., Sept. 3-5.

First International Congress of the Aeronautical Sciences, Palace Hotel, Madrid, Spain, Sept. 8-13.

American Rocket Society, Fall Meeting, Hotel Statler, Detroit, Mich., Sept. 15-18.

13th Annual Instrument Automation Conference, Convention Hall, Philadelphia, Pa., Sept. 15-19.

ASQC, 5th Annual San Francisco Bay Area Conference, Stanford University, Palo Alto, Calif., Sept. 19.

Professional Group on Telemetry and Remote Control, 1958 meeting, Americana Hotel, Bal Harbor, Miami Beach, Fla., Sept. 22-24.

Standards Engineers Society, Seventh Annual Meeting, Franklin Hotel, Philadelphia, Pa., Sept. 22-24.

Air Force Association, Airpower Showcase, Dallas, Texas, Sept. 25-27.

ASME Power Conference, Statler Hotel, Boston, Mass., Sept. 28-Oct. 1.

National Aeronautic Meeting, Society of Automotive Engineers, Inc., Ambassador, Los Angeles, Calif., Sept. 29-Oct. 3.

OCTOBER

Association of the United States Army 1958 annual meeting, Sheraton-Park Hotel, Washington, D.C., Oct. 20-22.

SAMA Laboratory Apparatus and Optical Sections' Midyear Meeting, Westchester Country Club, Rye, N.Y., Oct. 26-28.

Institute of Radio Engineers East Coast Conference, Aeronautical & Navigational Electronics, Lord Baltimore Hotel, Baltimore, Oct. 27-28.

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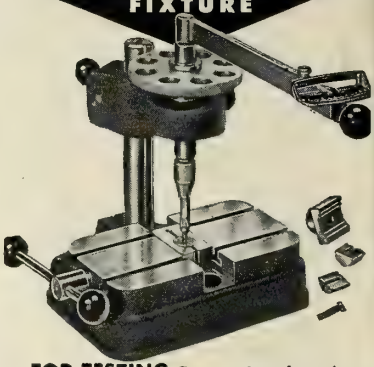
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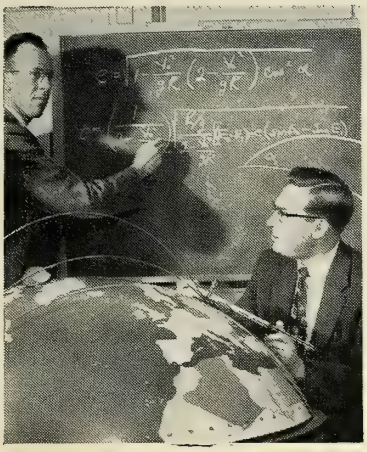


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Advertisers Index

	Page
AMP Inc.	37
Aeronutronic Systems, Inc., Sub. Ford Motor Co.	101, 162
Airborne Accessories Corp.	8
Aircraft Armaments, Inc.	102
AiResearch Mfg. Co., Div.— The Garrett Corp.	29
Allegany Instrument Co., Inc.	74
Allegheny Ludlum Steel Corp.	16
American Bosch Arma Corp.	104
American Brake Shoe Co.	4
American Machine & Foundry Co.	22
American Welding & Mfg. Co.	63
Barco Mfg. Co.	156
Beckman & Whitley, Inc.	89
Belfab Corp., The	151
Bendix Aviation Corp.,	
Pacific Div.	85
Bendix Products Div.	36
Scintilla Div.	56
Billings & Spencer Co.	90
Binkley Mfg. Co.	154
Blocksom & Co.	80
Bristol Co., The	150
Brunswick-Balke-Collender Co., The	48
Bulow Electric Co.	157
Camco Fittings, Inc.	58
Cannon Electric Co.	156
Canoga Corp.	97
Chance Vought Aircraft, Inc.	72, 73
Consolidated Controls Corp., Div. of Consolidated Diesel Electric Corp.	83
Consolidated Electrodynamics Corp.	78, 98
Continental Aviation & Engineering Corp., Sub. Continental Motors Corp.	99
CONVAIR, a Div. of General Dynamics Corp.	35
Convair-Fort Worth, a Div. General Dynamics Corp.	61
Cook Electric Co.	103
Cutler-Hammer, Inc.	19
Data-Control Systems, Inc.	52
Datasync, Div. of Berndt-Bach., Inc.	65
Delavan Mfg. Co.	93
Diversey Engineering Co.	6
Dunham-Bush, Inc.	67
Dyna-Therm Chemical Corp.	9
Eastern Industries, Inc.	161
Electrical Engineering & Mfg. Corp.	42
Ets-Hokin and Galvan	158
Eutectic Welding Alloys Corp.	101
Excelco Developments, Inc.	24
Ex-Cell-O Corp., Aircraft Div.	75
Fansteel Metallurgical Corp.	91
Flexonics Corporation	38
Flight Research, Inc.	88
Foote Bros. Gear & Machine Corp.	41
Ford Instrument Co., Div. Sperry Rand Corp.	14
Formsprag Co.	12
General Chemical Div., Allied Chemical Corp.	31
General Electric Co.	27
G. M. Giannini & Co., Inc.	54
Goodyear Tire & Rubber Co., The, Aviation Products	3
Haws Drinking Faucet Co.	102
A. W. Haydon Co., The	155
Herrick L. Johnston, Inc.	156
Hewitt-Robins Industrial Products	46
Hofman Laboratories, Inc.	100
Huck Manufacturing Co.	96
Ideal-Aerosmith, Inc.	94
Indiana Gear Works, Inc.	69, 70
Jet Propulsion Laboratory	25
Jordan Electronics	71
Kennametal, Inc.	153
L.O.F. Glass Fibers Co.	28
Laminated Shim Co., Inc.	47
LaVezzi Machine Works	155
Wallace O. Leonard, Inc.	82
Linde Co., Div.—Union Carbide Corp.	59
Lockheed Aircraft Corp.	20, 21
Lodge & Shipley Co., The	44
Johns Manville	23
Marman Div., Aeroquip Corp.	15
McCormick Selph	153
McDonnell Aircraft Corp.	79
National Airlines, Inc.	157
Newbrook Machine Corp.	76
Nuclear Products, Erco Div., ACF Industries, Inc.	34
Nutt-Shel Co., Inc.	10, 11
Pacific Automation Products, Inc.	13
Pressed Steel Tank Co.	84
Propellex Chemical Corp.	100
Radio Corp. of America	92, 149
Raybestos-Manhattan, Inc., Asbestos Textile Div.	152
Raytheon Mfg. Co.	18, 95
Republic Mfg.	150
Republic Steel Corp.	77, 79, 81
Resistoflex Corp.	17
Rockwell Standard Corp., Axle & Transmission Div.	57
Servomechanisms, Inc.	2
Skydyne, Inc.	94
Slip Ring Co. of America	156
A. O. Smith Corp., Aeronautical Div.	55
Standard Tube Co., The	62
Statham Instrument, Inc.	72
Stromberg-Carlson Co., Div. General Dynamics Corp.	33
P. A. Sturtevant Co.	158
Sundstrand Turbo, Div. Sundstrand Machine Tool Co.	30
Telecomputing Corp.	51, 86, 87
Thiokol Chemical Corp.	45
Townsend Co., Cherry Rivet Div.	64
United Aircraft Products	26
Utica Drop Forge & Tool Corp., Div., Kelsey-Hayes Co.	39
Vickers, Inc., Div.—Sperry Rand Corp.	32
Washington Aluminum Co., Inc.	51

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EMPLOYMENT SECTION

General Electric Co. 158, 159

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ded to the line of precision en-
osulated wirewound resistors manu-
tured by Mepco. Inc. Power range
1/8 to 1/3 watt at 125°C. Operating
ge is —65° to 145°C with a tem-
rature coefficient of 0.003%/°C.
pco, Inc.

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LEMETERING OSCILLATORS. Six new
tage-controlled subcarrier telemeter-
oscillators whose size, weight and
wer requirements are said to be the
allest on the market have been intro-
ced by Dorsett Laboratories, Inc.
odel O-22, little over a one-inch cube,
ws a total of 25 milliwatts; one volt
es 7½% frequency change; input is
megohm and output up to several
ts on RDB channels. Resistance to
ration and shock up to 20g and 2000
cles is specified.

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NCROVERTER SWITCHES. Miniature
rmetically-sealed syncroverter switches
being packaged for modular-type
uipment. The choppers functionally
te with the Cannon KO2-16-10SN
ceptacle and retain non-resonant per-
mance of previous models. Units are
signed to operate at extremes of alti-
de, temperature, shock, vibration, and
oustic noise. The Bristol Co.

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ANSISTORIZED VOLTAGE REGU-
TOR. Model PR-10, a completely
nsistorized dual dc voltage regulator
pable of operation under severe en-
onmental conditions. Designed to pro-
de stable positive and negative 20-
lt dc power source. Sealed against
ngus and humidity. Measures 3" x
37" x 1.62" with a total weight of
3 oz. United Electrodynamics.

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ARIABLE TOROID. Developed for
inted circuit and similar lightweight
pplications, the variable toroid is her-
metically sealed, there being no contact between the adjusting screw and the toroid itself. Stepless adjustment of inductance over a 10% range is provided and torque adjustment is such as to preclude possible strain on printed circuit mounting. Burnell & Co.

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SIZE 6 SERVOMOTOR. One of the smallest practical servomotors developed. Weighing only .9 ounces, this motor will develop a stall torque of .125 oz-in., and has a free speed of 6,200 rpm. The unit is available for 400 cycle operation with 26, 33 or 52 volt control phase windings. The control phase is center-tapped for operation directly with transistor amplifiers. Operating temperature range is from –550 to +1120C. Has been specifically developed for military applications, where high response, extreme size, and weight limitations are of great importance. Daystrom Transicoil Corp.

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MINIATURE CHECK VALVES. Available within all styles of AN and MS fittings. Obtainable in both 1,500 P.S.I. (aluminum) and 3,000 P.S.I. (stainless) featuring zero reverse flow leakage with operating temperature range of 110°F to 500°F. Spartan Aircraft Supply Co., Inc.

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TRIAXIAL RECORDING ACCELEROMETER. Senses and records data for plotting acceleration versus time under extremely rigorous conditions. Its three sensing elements are located mutually perpendicular, so if there is no predominate acceleration along one axis, the three plots can be added vectorially to give the peak acceleration and the direction in which it was acting. The unit is self-contained (requiring external power only). It will record from 250 to 10,000 g. The maximum dimension is 2 1/16 inches. Weight, six ounces. Engdahl Enterprises.

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• • Advertisements

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125
126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150
151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175

• • Missile Literature

200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224

• • New Missile Products

225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245	246	247	248	249
250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	274
275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299

For Other Information Give Page Numbers:_____

MISSILE LITERATURE

NEW ELECTRONICS DEVELOPMENTS. New aids in electronic chemicals, hardware, switches and service tools are featured in this 80-page catalog. Book is sectionalized for reference to categories such as cements and chemicals, alignment tools, service aids, speaker kits, test leads, switches, etc. General Cement Mfg. Co.
Circle No. 200 on Subscriber Service Card.

MOTOR-GENERATOR. Servomotor and rate generator said to perform like size 10s but fit in a housing for size 8s are described in a brochure published by Helipot Corp.
Circle No. 201 on Subscriber Service Card.

DC TO DC POWER SUPPLY. Described in detail in data sheet is a compact, lightweight, transistorized dc to dc power supply for use where efficiency and reliability are prime considerations. Computer Engineering Associates, Inc.
Circle No. 202 on Subscriber Service Card.

TRANSFORMERS. Four-page brochure illustrates new facilities and various types of transformers constructed by Eisler Transformer Co., Inc.
Circle No. 203 on Subscriber Service Card.

TRANSISTOR CHARACTERISTICS. Booklet lists electrical characteristics and interchangeability features of a wide variety of transistors by type number and manufacturer. The 20-page booklet lists maximum ratings, typical values and applications for all transistors in the Sylvania line. In addition, the interchangeability guide will enable engineers, experimenters and servicemen to select the proper replacement for more than six hundred types of transistors currently on the market. Sylvania Electric Products, Inc.
Circle No. 204 on Subscriber Service Card.

MAGNETIC AMPLIFIERS. Application Notes No. 5 on "Design of Pulse Magnetic Amplifiers" and No. 6 on "Pulse Magnetic Amplifier—Logic Circuits" deals with the design of magnetic amplifiers using silicon diodes and magnetic cores. The notes show how greater reliability and flexibility can be achieved in "logic circuitry" by the use of silicon diodes combined with magnetic cores, more than previously was accomplished by vacuum tubes and relays which have been previously used for logic functions. Hoffman Electronics Corp., Semiconductor Division.
Circle No. 205 on Subscriber Service Card.

CAPACITORS. A four-page technical bulletin describing a complete line of fixed and variable capacitors for use as precision laboratory reference standards has been issued. These capacitors range from 10 micro-microfarads to 4 microfarads and include variable capacitors ranging from 6 to 230 mmf. They are adjusted to .1% and furnished with individual calibration certificates. Stability is guaranteed with .05% per year and, with proper care and usuage, can be expected to be within .01% per year. International Telephone and Telegraph Corp., Industrial Products Division.
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CEMENTABLE TEFLON. Specially-treated teflon that readily accepts adhesives or bonds is described in this 4-page booklet. Only the treated surface of the material is changed, the balance of the teflon retaining its insulating, chemical-resistant, heat-resistant and low-frictional qualities. Thicknesses, tolerances, bonding techniques and recommended applications are included. Continental-Diamond Fibre Corp.
Circle No. 207 on Subscriber Service Card.

QUALITY CONTROL. This 24-page illustrated booklet, known as Bulletin TB-420, describes the various testing and inspection methods used during the manufacture of B&W's line of seamless and welded carbon, alloy and stainless steel tubular products. The booklet explains how these inspection and testing techniques are integrated into the manufacturing process. Babcock & Wilcox Co., Tubular Products Division.
Circle No. 208 on Subscriber Service Card.

PROPELLANT ACTUATED DEVICES. Six generic types of products utilizing propellant cells for their initiating power are described and illustrated in this folder. Devices include guillotine-type cutters, destructors, electrical disconnects, frangible fasteners, igniters and valves. Beckman & Whitley, Inc.
Circle No. 209 on Subscriber Service Card.

FLEXIBLE BALL JOINTS. Designed for handling liquid oxygen and high energy fuels, these flexible ball joints are illustrated and described in a four-page catalog. The joints provide for either swiveling or angular flexing movement and for thermal contraction in piping. Barco Mfg. Co.
Circle No. 210 on Subscriber Service Card.

MAGNESIUM-THORIUM ALLOYS. The design and shop characteristics of the magnesium-thorium alloys are covered in a booklet listing elevated temperature uses. Booklet presents various property data for the alloys, and includes a comparison of their structure temperatures with those of other metals for different flight times, mach numbers and altitudes. Dow Chemical Co.
Circle No. 211 on Subscriber Service Card.

GROOVING & CUTOFF TOOLS. Color folder, designed for grooving and cutoff tool users, provides visual guide to types of tools produced, illustrates mirro-lap finish and supplies data on finishes, tolerances, types and tool materials. Acme Grooving Tool Co.
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26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125
126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150
151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175

• • Missile Literature

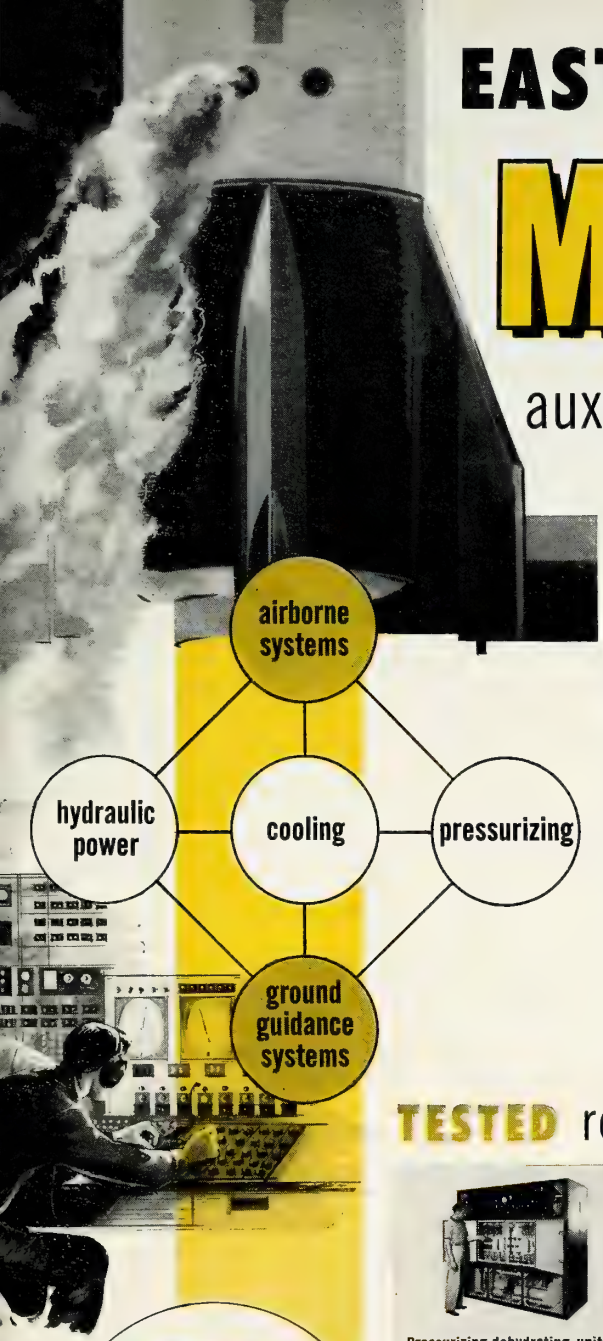
200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224

• • New Missile Products

225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245	246	247	248	249
250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	274
275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299

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EASTERN . . . pioneer in MISSILE auxiliary power subsystems



Eastern has developed miniature, high-output units that give reliable performance in missile auxiliary power systems. Coordination with developers at the planning stage permits Eastern continually to engineer lower weight units that allow more fuel load for longer flight duration. Eastern's experience as pioneers of the thermal frontier provides the all-important knowledge to solve temperature problems at each stage of missile development.

HYDRAULIC POWER UNITS

Miniature high-speed gear pumps are powered by aircraft motors up to 24,000 R.P.M., or direct-driven by the turbine with little or no reduction gearing needed. Missile design engineers get maximum flexibility, reliability, and simplicity with separate hydraulic systems. Eastern has produced power packs with capacity to 1.5 G.P.M. at pressure to 2,500 P.S.I. Units are completely sealed and have pressurized sumps for operation at any altitude and attitude.

ELECTRONIC TUBE COOLING UNITS

Liquid cooling of heat-producing electronic equipment is an efficient, reliable control of temperatures within safe operating limits. By creating designs based on pioneering experience, Eastern provides compact, lightweight equipment for up-to-the-minute missile needs that meet military requirements.

Cooling units have 50 to 50,000 watts dissipation rates, and refrigeration-type cooling units are furnished from 100 to 6,000 watts. Come to the **leader in the field** for complete and creative engineering help.

EASTERN PRESSURIZATION UNITS

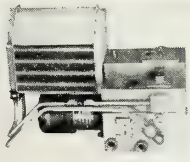
Vital electronic systems that depend on a supply of precisely controlled dry pressurized air are protected by these units. A continuing program of research and development on compressors, dehydators, and air control systems insures that your Eastern pressurization unit features the very latest advances in this field for compactness, high temperature resistance, and reliability. They are custom-made to your special needs and meet rigid military specifications.

TESTED reliability in auxiliary power

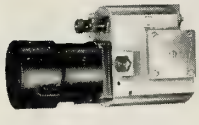
Pressurizing-dehydrating unit used in tracking and guidance system of ground-based missile controls.



High-speed gear pump provides hydraulic power to missile as integral part of APU system.



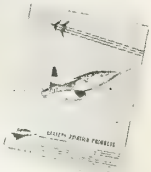
Cools high-powered electronic tubes in guidance sections of missiles.



Eastern power-pack gives hydraulic power for missile elevons and wing-folding actuators.



Maintains sensitive reference component within exact temperature limits. Dissipates 350 watts by "boiling off" water in supply tank.



NEW AVIATION BULLETIN 350 Brand new edition gives data on latest developments in hydraulic power, cooling pressurization. Send for copy today.

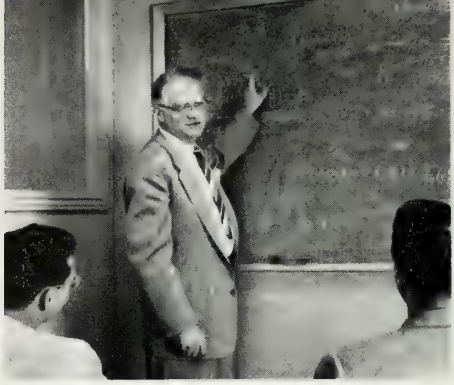
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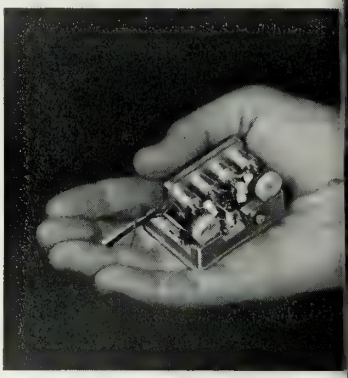
Dr. Montgomery H. Johnson, Director of Aeronutronic System's Advanced Research Staff, discusses problems related to lunar research flights. Other Advanced Research Staff interests include the study of air opacity, infrared missile emissions, and high altitude and free space nuclear explosions.



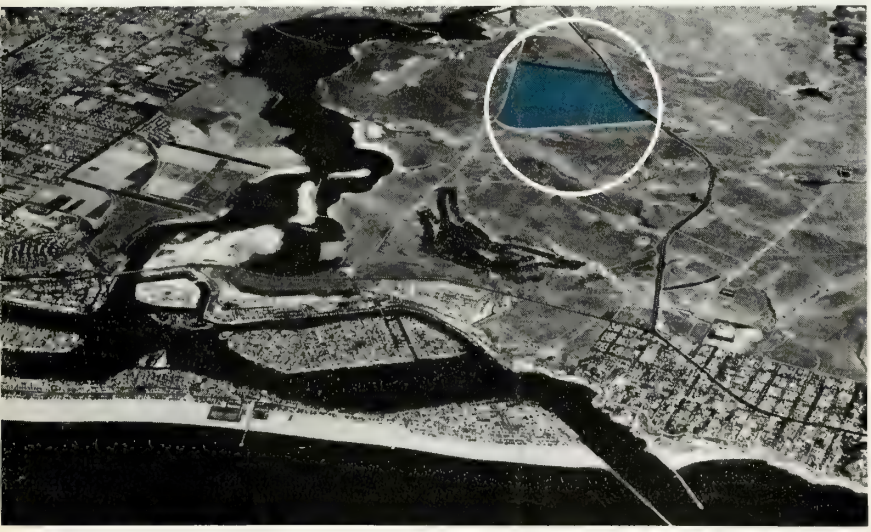
Far Side Missile developed by Aeronutronic fo Office of Scientific Research. Four-stage roc this were balloon launched and fired to record t altitudes where they measured the Earth's m field and cosmic radiation intensities.

How Aeronutronic is meeting the needs of advancing science and technology

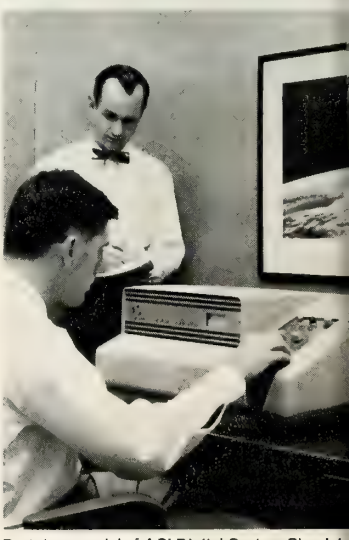
The Ford Motor Company established Aeronutronic Systems, Inc. to engage in the development and manufacture of highly technical products for military and commercial purposes. In a time of expanding science, Aeronutronic is meeting the technological needs of the Nation. A few of Aeronutronic's broad interests and activities are illustrated here.



ASI Model IL-101 Subminiature Transmitter p exceptional frequency stability under high accel space conditions. Size of unit: 1.1 x 1.4 x 2 Weight: less than 5 ounces. Output: 150 ±



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Prototype model of ASI Digital System Simulato is designed to give direct check of reduction of equations, to study a system's operations p construction, and to study alternate logical de

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AUGUST 4, 1958

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MAGAZINE OF WORLD ASTRONAUTICS

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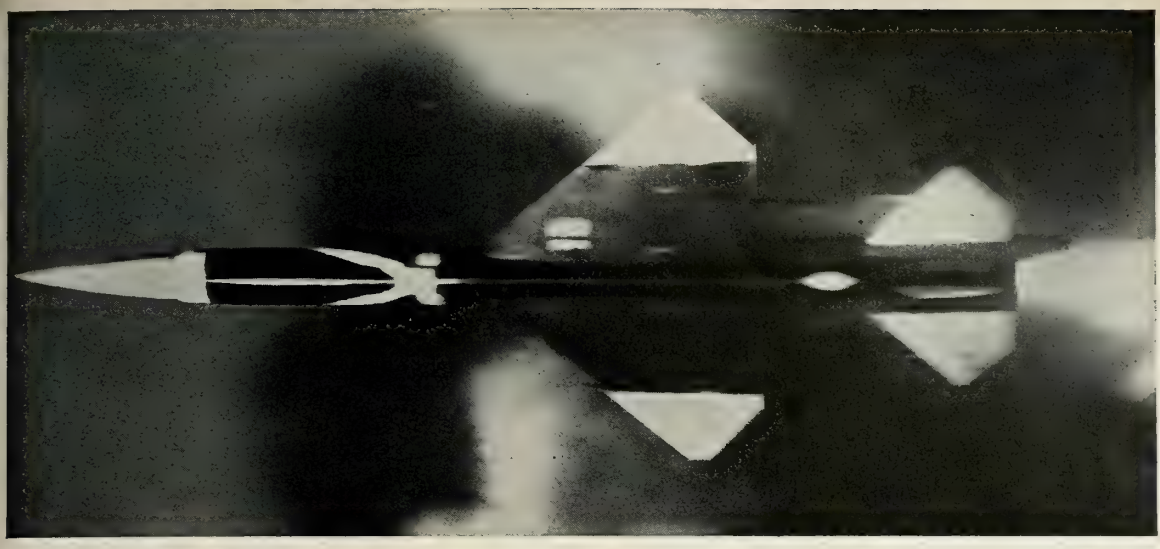
Producing Controls for every Basic Airborne System

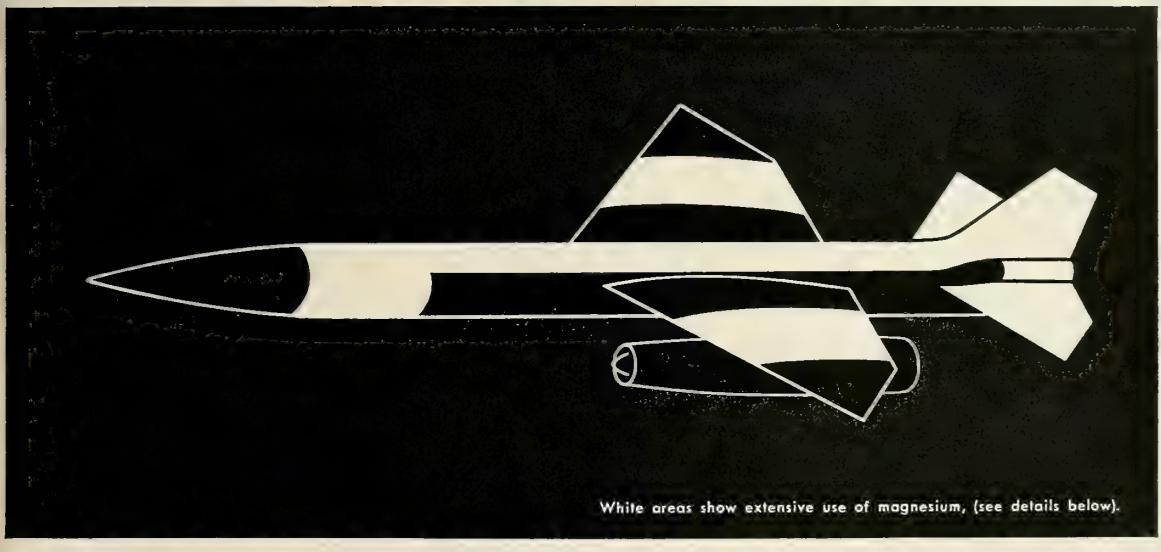
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White areas show extensive use of magnesium, (see details below).

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Approximately 230 lbs. of magnesium is used in the airframe of the Bomarc, powerful surface-to-air missile. And for good reason: In each case, the specific application called for light weight and retention of strength, rigidity and other properties at elevated temperatures. The logical choice was sheet, extrusions or castings of elevated-temperature magnesium alloys.

EXAMPLES:

BODY. The body skin and doors of both nose and aft sections utilize 103 lbs. of HK31A sheet and castings. Resultant weight savings were 23 lbs., including a net reduction of 6 lbs. by using a magnesium casting for a door frame structure.

WING, FIN AND TAIL. 111 lbs. of HK31A sheet were used in the wing, elevators and elevator stubs, fin and rudder. All leading and trailing edges of control surfaces for wings and fin are HM31XA extrusions. Here another 8 lbs. were saved by using an elevated-temperature magnesium alloy.

These are but a few instances of how precious weight was saved in the Bomarc. For more information about the use of magnesium alloys in aircraft, rockets and missiles, contact the nearest Dow sales office or write directly to us. THE DOW CHEMICAL COMPANY, Midland, Michigan, Department MA 1407L-3.

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missiles and rockets Vol. 4, No. 5, August 4, 1958

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AUDITED PAID CIRCULATION ABC — NBP — BUSINESS PAPER LEADERSHIP ABP

editorial viewpoint . . .

Now—following Russia by three long, and perhaps disastrous years—the United States has formed a space agency. By title, it is half aeronautics and half astronautics. Nonetheless, it represents a well-meaning, though partial, effort by government to provide effective leadership and organization to bridge the gap in space technology between this nation and the Soviet Union.

The impetus for this new agency came last fall, when the U.S. found out that the world was on the threshold of a new frontier—but, that we were not the first to enter the space age. Suddenly, everyone was interested in space technology. "Authorities" grew up overnight, and an excited Congress went to work. The new National Aeronautics and Space Administration is the result.

We wonder whether today's space-minded Congress may become complacent when, and if, the U.S. matches Russia's current orbiting weight contest. Will money then be readily available for the next steps—the "peaceful" exploration of space, which Congress has demanded?

Or at that time will NASA recede to the position of the U.S. Weather Bureau and other agencies, which, although scientific in scope, eke out a yearly subsistence from Congress? Will we then have to use the hypocritical camouflage of "military necessity" to justify space exploration?

Ten months after *Sputnik* I, there is a growing tendency of the American public to take space technology for granted. It is assumed that in the U.S., our best—and that includes space technology—automatically is the best in the world. But, we have forgotten one fact: The U.S. is years behind, and Soviet Russia is working harder than we are to achieve pre-eminence in the exploration of space. Clearly then, the task ahead is education, both for Congress and the NASA.

NASA is beginning with many strikes against it. It will be unable to hire but a few top scientists because of ridiculously low salaries set by Congress—salaries ranging downward from a top of $22,500.

Within a couple of months, NASA will probably be "investigated" to determine why there have not been major technological breakthroughs. Add the forthcoming "differences of opinion" in the "gray areas" of what constitutes military vs. civil space exploration, and it spells rough days ahead for the new agency. But we wish NASA the best of luck. It will be needing it.

contents

news

U.S. Readies Missile Makers' Planning Forms
by Seabrook Hull 12
Soviets Push Missile Plastics
by Alfred J. Zaehringer . 14
Nike-Cajun Measures Humidity 14
New Propellant Battleground: Aircraft-Carried Missiles . 15
Senate Approves $40.03 Billion Military Budget 16
Atlas Shows Off Its Power ... 20
Complex Arms Hurt Small Firms
by Frank G. McGuire .. 24
Army *Explorer* IV Shot To Produce Scientific Data
by Norman L. Baker ... 28
A Billion-Dollar Firm Shifts Into Space
by Erica Cromley 31

columns

Industry Countdown 9
Washington Countdown 11
Missile Business 21
Propulsion Engineering 27

departments

Contract Awards 21
Missile People 34

cover

The missile that looks like a bomber hanging under the Navy attack plane is Royal Industries' Boar, a rocket-boosted "over-the-shoulder" toss bomb. The unguided missile, carrying a nuclear warhead, is now in operational service with the Navy. This is the first identifiable picture ever published of the Boar.

Hydra-Headed Hydride



RESEARCH on Lithium Hydride has its metaphoric parallel in Greek Mythology. Hydra the sea serpent possessed nine heads, each of which when cut off was replaced by two more. As the major producer of LiH, we see a similar, ever increasing technological and scientific interest in this versatile compound: every new application suggests another two.

9 USES and POSSIBLE USES: Do They Suggest a Parallel to YOUR Problem?

COMMERCIAL

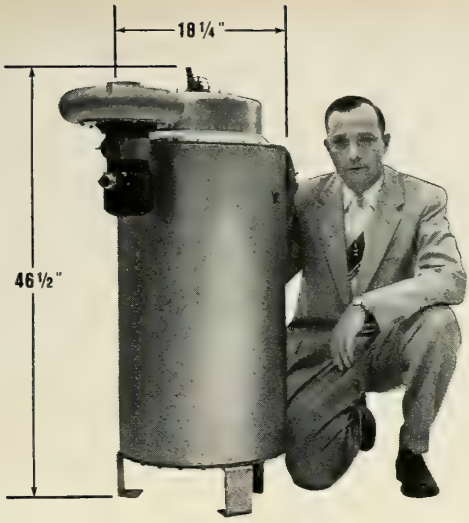
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MILITARY

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7. High Energy Fuels: Starting material for the manufacture of decaborane ($B_{10}H_{14}$).
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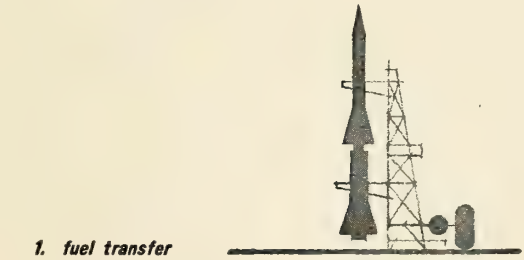
For missile ground support applications this compact new Janitrol liquid heater delivers heat up to a rate of 1 million Btu/hr. A complete variable output heating system, it automatically maintains liquid at any desired temperature . . . reliably.

This 257 pound package is ideally suited to such applications as heating missile fuel during storage and transfer, vaporizing liquids, and in a wide variety of support vehicles and buildings. For both material and personnel comfort heating the new Janitrol liquid heater is a simple, trouble-free way to get large quantities of controlled heat.

Heater burns either diesel fuel, gasoline, or JP-4, and can be converted with a simple adjustment. Radio noise shielding meets military specifications. It will operate in extreme environments to —65°F.

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Wherever heat is needed in missile support equipment Janitrol may already have what you need. Contact your Janitrol representative now for the full story on liquid heaters. Janitrol Aircraft Division, Surface Combustion Corporation, Columbus 16, Ohio.



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2. support vehicles



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INDUSTRY COUNTDOWN

MERGERS AND EXPANSIONS

Lockheed will build a $7 million addition at Sunnyvale, boosting capacity from 1,342,000 to 1,687,000 sq. ft. Plans call for completion by fall, 1959 . . . **Canadair Ltd. is constructing** a $1 million environmental lab for its missile programs in the Montreal suburb of St. Laurent . . . **Westinghouse Electric opened** a defense products sales office at 600 Old Country Road, Garden City, Long Island . . . **Mandrel Industries bought** the entire inventory, tooling, machinery and equipment of Hall-Scott Electronics division at Burbank . . . **Raytheon established** a Government Relations Office at Rome, N.Y. on August 1st . . . **Arnoux Corp. opened** a western regional office at 291 South LaCienega Blvd., Beverly Hills . . . **Pacific Semiconductors Inc. will build** a $10 million center employing 3,000 near the Los Angeles International Airport. When completed, it will comprise 300,000 sq. ft. . . .

Advance Industries of Cambridge, Mass. purchased 100% of the outstanding stock of The Electrolizing Corp. of Rhode Island. The acquisition includes Electrolizing's 100% stock of High Temperature Coatings Inc., Rhode Island, and 80% of Flame Ceramics Inc., Santa Monica . . . **Technitrol Engineering Co. of Philadelphia** opened a west coast office at 252 N. Irving Blvd., Los Angeles . . . **Hoffman Electronics Corp.** acquired 40,000 additional sq. ft. in Evanston to manufacture semiconductors and silicon solar converters . . . **First privately-owned** (by The Beryllium Corp.) integrated beryllium plant opened in Hazleton, Pa. Only previous comparable plant was owned by the AEC.

NEW FUNDS

Conference-approved version of FY 1959 appropriation of $101.1 million for NACA is low because of expected additional requests when NASA absorbs NACA . . . **ARPA will use** $24 million of its recently appropriated $50 million for a "highly classified project"—probably the bomb-powered rocket . . . **Senate Military Appropriations Subcommittee** went along with House increases of $609 million for four more *Polaris* submarine weapons systems. It also concurred with the House increases of $90 million for *Minuteman* and $48 million to step up *Hound Dog* . . .

Army plans to double its funds for basic research to prevent repetition of current R&D cycles, and will urge its contractors to follow suit . . . **Administration wants a temporary debt** ceiling of $288 billion until June 30, 1959, and then a permanent ceiling of $285 billion thereafter. DOD officials state that there will be no repetition of last years spending ceiling and weapons cutbacks if the debt limit is raised . . . **House-passed military construction bill** authorizing $1,218,815,000 in new funds went to the Senate. Breakdown was: $214,564,000 for the Army, a cut of $126,336,000; $282,751,000 for the Navy, a reduction of $85,502,000; and for the Air Force, $701,500,000, a reduction of $300,000,000.

HOW'S BUSINESS?

Martin Co. reports $91,864,495 sales and $1,896,740 net earnings (65 cents per share) for the 2nd quarter of 1958 compared to $96,361,490 and $1,693,531 (58 cents per share) for first quarter . . . **Profit of 22 cents per share** for the second quarter has reduced a first quarter loss of 44 cents per share to make a net loss of $104,000 for the first six months of 1958 for Fairchild Camera and Instrument . . . **Solar Aircraft's 1958 annual report** showed increased (by $1 million) working capital, decreased (to $5 million) bank loans and all-time high shareholder equity of $15,774,000 . . . **Thiokol Chemical anticipates** that sales of its Chemical Division will amount to $9.5 million for 1958, up 30% over 1957 . . . **Ling Electronics** announced receipt of $5 million in orders in the past 90 days . . .

Sales of Air Reduction for second quarter were $42,363,939 compared to first quarter figure of $46,815,125, a decline of 9.5%. Net income declined 18%, over comparable quarter in 1957, from $3,885,106 to $3,185,667. Regular quarterly dividend of 62½ cents per share will be paid, making it the 165th consecutive payment on common stock . . . **Ampex Corp. increased** earnings 41% in its FY 1957 ending 30 April on sales of $30,115,000 and after-tax earnings of $1,540,000, both new company highs . . . **Stavid Engineering received contracts** totaling $7,647,874 in first six months of 1958. Figure for comparable period last year was $4,859,926 . . . **Packard Bell's net** jumped 37% to $633,948 on sales of $26,401,343 for nine months ending June 30th . . . **Miniature Precision Bearings Inc.** recorded sales of $5,486,000 and after-tax profits of $297,000 for the fiscal year ending March 31st. Figures for the preceding year were $3,864,000 and $242,000, respectively . . . **Chance Vought earned** $4.35 per share in the first six months of 1958 on sales of $153,836,946, compared to $1.95 per share and sales of $86,044,763 in like period last year. Backlog climbed from $467 million to $542 million for same periods.

What's new in TITANIUM pricing:

Recent price reductions in titanium metal—the seventh initiated by Titanium Metals Corporation of America since 1954—have provoked renewed interest in the design properties of the material.

With prices down 45 percent from levels four years ago, and weight, heat, and corrosion problems severely increased in aircraft and missiles now being devised, titanium metal's role is growing ever more important.

The purchasing of titanium can sometimes be a complex task. TMCA hopes it can help you in that task by passing along some reminders on methods to save money on the "price extras" that apply to all orders of titanium metal. Of course, design considerations are paramount, but sometimes slight changes that can be tolerated by engineering can mean large cash savings.

✱ QUANTITY

Production costs decrease as the amount of material being processed increases. Therefore, quantity schedules have been established to pass along economies to the purchaser. A customer can often benefit by careful consideration of the amount of material he is ordering, compared to the quantity schedule as outlined in TMCA's Buyer's Guide. In many cases, because of applicable quantity extras, upwards of 1,000 pounds of titanium metal are available at no charge to the purchaser. For example, a 10,000 pound shipment of heat-treatable forging billet can cost exactly the same as a 9,074 pound order; a 5,000 pound shipment of plate can cost exactly the amount of a 4,802 pound order. TMCA's district sales managers are always willing to help you take advantage of the price breaks.

✱ PATTERN SIZES

Although ordering by pattern sizes is an established procedure with more common engineering materials, it isn't always the most economical method with titanium. For example, when small parts are to be cut from sheet, ordering "random size" will save you 75 cents per pound of material. The price allowance is applicable when *specific sheet sizes are ordered,* but shipment is permitted in widths ranging from −6″ to +2″ and lengths ranging from −18″ to +12″. Weight of random size sheets and exact size sheets of the same gage can be combined when computing quantity prices for a given order.

✱ TOLERANCE

Here important weight saving advantages are accorded designers and cost savings accrue to purchasing. Material specified ½ AISI tolerance weighs 10% less than standard-tolerance material.

TMCA's district sales manager will be happy to provide you information on grades and products where this tolerance schedule applies.

✱ WIDTH

If you determine the end use of metal before ordering, you will sometimes realize important cash savings. For example, titanium metal 24″ wide is classified as "sheet," and sheet prices apply. However, by ordering material 1/16″ less in width, strip prices apply at a savings of 50 cents to $1.00 per pound.

✱ THICKNESS

A more substantial saving is possible in specifying plate rather than sheet where the substitution meets design requirements. Metal 0.187″ thick is priced as sheet. However, metal 0.1875″ is priced as plate at a savings of $2.10 per pound.

✱ SIZE

A size extra of 20 cents per pound applies to billets 8″ or less in diameter. However, billets 8 1/16″ in diameter are supplied at base price. If the additional 1/16″ can be tolerated by design, the financial savings on material can be realized.

These are just a few examples of the money savings possible through careful study of the "price extra" sections of your Buyer's Guide.

Fixed, published schedules are vital in guaranteeing standard quotations to all customers in highly competitive work. By the same token, TMCA customers will receive every pricing benefit possible under these schedules.

* * * * * *

If you are placing an order for titanium, or considering purchase of titanium, contact the TMCA sales manager in your district. He can help save you money and time.

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WASHINGTON COUNTDOWN

• **THE PASSWORD** in Defense circles this week is reorganization. With the overall reorganization program closer to being law, all branches of the military stepped up their individual programs to fit into the new pattern.

• **THE NECESSARY MERGING** of functions and responsibilities will result in abolishment of a number of offices and the creation of others. Many of the functions now under military heads will move to civilian-skippered offices, and vice-versa. Indications are that the Navy, for example, will cut back to a maximum of three assistant secretaries, maybe only two. Also, the Undersecretary billet stands a good chance of being abolished.

• **THE OFFICE OF THE ASSISTANT SECRETARY FOR PERSONNEL** probably will get considerable face-lifting. One of the combined responsibilities mentioned is one assistant secretary for Finance and Personnel. A second for Research and Development and Material would provide for the Office of Naval Research remaining directly under the office of the Secretary of the Navy.

• **IN ONE WAY,** the reorganization is providing an opportunity for a number of changes long overdue. One of the changes which will be effected soon, if not immediately, is the establishment by the Navy of a Bureau of Weapons. Because of the complexities brought on largely by missile development in several different branches—such as the Bureau of Ships, Bureau of Ordnance and Bureau of Aeronautics—an overall Weapons Bureau seems the answer. Rear Admiral W. F. Raborn, head of the Special Projects Office supervising the Fleet Ballistic Missile program, is the best bet to head the new Bureau of Weapons when established.

• **A NEW SECRETARY OF THE NAVY** is another distinct possibility. Secretary Gates has made no bones about not wanting to stay much longer in his job, reorganization or no. As mentioned previously in this column Gates has said a man loses his usefulness after just so long in official Washington circles. Out front as choice for the top Navy executive's job is Assistant Secretary for Financial Management, J. Sinclair Armstrong. Armstrong has a number of things in his favor—his youth, his aggressiveness, his previous good record—not to mention his popularity in White House circles.

• **ONE APPROPRIATION BY CONGRESS** is being viewed with mixed emotions in some of the military circles. The lawmakers, many of whom have been the strongest voices for reorganization and elimination of competition between the services, boosted maintenance of the Offices of Information and the Offices of Legislative Liaison. In addition to many good reasons, the congressmen simply like being courted by more than one suitor.

• **AS ARMY SPACEMEN** planned the launching of the fourth *Explorer* satellite last weekend, it was obvious that the long time between shots (about four months) was due to something. In addition to instrumentation problems the delay could have been due to concurrent concentration on the first two or three lunar probes, which probably will be launched in late September or October.

• **MEANWHILE,** don't be surprised if the Air Force gets off a shot at the moon before the end of August. The main objective of these last *Explorer* shots is to measure and define more accurately the radiation band recorded by earlier satellites, and to try to determine whether its source is the sun or if it comes from interstellar space beyond the sun. Should it be found that the sun is not the source of all the radiation, a number of scientific theories will be up for revision.

• **THE RENEGOTIATION ACT** was scored by representatives of the Aircraft Industries Association, appearing before the House Ways and Means Committee, presently considering a two-year extension of the act.

AUGUST 4, 1958
VOL. 4, NO. 5

missiles and rockets
MAGAZINE OF WORLD ASTRONAUTICS

- **A Whole Set of New Business Procedures in the Making**
- **Result will be Performance, Profit Check for U.S. Business**

U.S. Readies Missile Makers' Planning Forms

by Seabrook Hull

After a frustrating four-and-a-half years, the Bureau of the Budget and the Armed Services appear at last to be on the verge of adopting a series of Missile Manufacturers Planning Report forms.

The MMPRs will be to missile makers what the Aircraft Manufacturers Planning Reports are to producers of aircraft and aircraft components.

Previously, missile-makers were asked to report on AMPR forms, but the data produced proved to be uncollatable. As a result, the Budget Bureau requested that new forms be developed that would be applicable to the peculiarities of missile and major missile segment production.

The current MMPR "M" forms, now in the final stages of adoption, are the outcome of this effort. It is expected that the first forms will be sent out to industry late this fall or in the first quarter of 1958.

A proposed handbook on the forms sets out the purposes of the reports:

• **Better reporting**—"The aim of the MMPR is to establish a clear and uniform reporting system that is designed to collect data that will best serve as a tool for military weapon system planners in their industry, contractor and program planning and evaluation, mobilization planning, and for other projection purposes."

Specifically, there is a current need for data that would enable the services to:

1. Make periodic surveys of the production status of companies.
2. Make periodic determination of the production capacities of facilities for mobilization purposes.
3. Plan and schedule feasible production programs.
4. Determine the manpower required to support such programs.
5. Measure the utilization of plant area and labor.
6. Develop a group of industry averages against which the reporting companies may measure performance.
7. Carry out research in order to refine currently-employed planning factors and to develop planning factors.
8. Maintain a library of missile weapon system data for use by the Government Services.
9. Provide production planning guidance to contractors by making available to them statistical parameters developed from the reporting system.
10. Develop formal studies and tools as required by other government services.

• **Broad coverage**—Under the heading "B. Scope," the handbook goes on:

"An MMPR will be submitted by all guided missile, rocket, drone and target missile contractors that have a pre-production and/or production contract unless specifically exempted by the contractor's cognizant service.

"The end use of the guided missile being produced is not the report determination criterion—the service's requirements for information in all instances will be the determining factor. The instructions and definitions provided in the following sections are guided missile and rocket oriented. Deviations necessary for drone and target missile reporting will be resolved individually with pertinent reporting contractors. . ."

• **Why necessary**—In summary, the Government wants a means of determining, first, what it takes in man-hours and facilities to make a missile and its parts; second, what the potential capacity of the country is—in case the need arises to push the "all-out" button and go on a wartime production basis.

Those expected to report will be the company that assembles the bird (prime contractor), and those companies responsible for making the major segments.

The MMPR instruction handbook defines these catagories as: guidance, power plant, structure (in government parlance, "airframe" is being dropped as a recognized missile term), mated segments, recovery system, armament, controls and multi-purpose energy systems, instrumentation.

MMPR Forms M-1, Production Support and Test and Checkout Data; and M-2, Direct Man-Hour and Flow Time Data; cover pre-production (non-recurring) effort (M-1) and actual production effort (M-2).

Form M-3, Composite Information, concerns itself with plant utilization—how much can be utilized as compared to the total available. Forms M-4 and M-5 cover Plant Area and Electrical Capacity; and Work Schedule of Direct Workers, respectively.

All-told, there are four quarterly reports to be made out and one semi-annual form (M-4).

• **Companies required**—Those companies used to supplying data under the Aircraft Manufacturers Planning Report will find nothing startlingly new in the MMPRs.

However, companies that now make major missile segments, but who have never done the same for aircraft, are in for an education in government paper work. Only those companies that make the completed segment need report; sub-segment suppliers and vendors probably will not be involved.

MMPR "M" series of forms include those parts of the bird that actually fly. Plans are now being instituted to work up an "S" series of forms for all support (non-flying) gear. These will cover all types of missiles—air-to-air, air-to-surface, surface-to-air and surface-to-surface. However, though the adoption of standardized forms and terms is expected to be more difficult than for the "M" series, less detail is going to be required, primarily because ground (or airborne) support and launching gear is usually a non-recurring expense.

• **Form development**—The forms illustrated with this article were interim. However, except for some

reports on use, cost of labor . . .

MISSILE MANUFACTURER'S PLANNING REPORT
MISSILE SEGMENT–
DIRECT MAN-HOUR AND FLOW TIME DATA
(MMPR M-2)
(DUE DATES: 30 January, April, July, and October)

WEAPON SYSTEM TITLE
MODEL IDENTIFICATION
CONTRACT NOS (Use separate sheet if necessary)
WEAPON SYSTEM PRIME CONTRACTOR
SEGMENT–PRIME RESPONSIBILITY
COMPANY MAILING ADDRESS
REPORTING PLANT
OTHER PLANTS INCLUDED

SEGMENT(S) REPORTED
☐ GUIDANCE
☐ POWER PLANT
☐ STRUCTURE
☐ MATED SEGMENTS
☐ RECOVERY
☐ ARMAMENT
☐ CONTROL & MULTI-PURPOSE ENERGY SYSTEMS
☐ INSTRUMENTATION AND MISCELLANEOUS
☐ _____

FORM APPROVED
BUDGET BUREAU NO.
REPORT CONTROL SYMBOL
FOR QUARTER ENDING:

SECTION I–MONTHLY INFORMATION (On-Site)
DIRECT MAN-HOURS (000)

MONTHS		LAST CUMULATIVE SEGMENT ACCEPTED OR COMPLETED	METHOD OF ACCT'G	COMPLETE SEGMENTS: FABRICATION	ASSEMBLY	TEST AND CHECK-OUT	ALL OTHER	TOTAL FOR COMPLETE SEGMENT	SPARES	MISCELLANEOUS	TOTAL SEGMENT EFFORT
		a	b	c	d	e	f	g	h	i	j
0. LAST MONTH OF PREV. QTR.			ACTUAL								
			STD.								
REPORT QUARTER	1		ACTUAL								
			STD.								
	2		ACTUAL								
			STD.								
	3		ACTUAL								
			STD.								
FORECAST	4		ACTUAL								
			STD.								
	5		ACTUAL								
			STD.								
	6		ACTUAL								
			STD.								
	7		ACTUAL								
			STD.								
	8		ACTUAL								
			STD.								
	9		ACTUAL								
			STD.								
	10		ACTUAL								
			STD.								
	11		ACTUAL								
			STD.								
	12		ACTUAL								
			STD.								
	13		ACTUAL								
			STD.								
	14		ACTUAL								
			STD.								
	15		ACTUAL								
			STD.								

SECTION II–LEARNING CURVE INFORMATION (On-Site)
AVERAGE DMH PER LOT OR UNIT

LAST CUMULATIVE SEGMENT	METHOD OF ACCT'G	FABRICATION	ASSEMBLY	TEST AND CHECK-OUT	ALL OTHER	TOTAL
a	b	c	d	e	f	g
	ACTUAL					
	DEV					
	ACTUAL					
	DEV					
	ACTUAL					
	DEV					
	ACTUAL					
	DEV					
	ACTUAL					
	DEV					
	ACTUAL					
	DEV					
	ACTUAL					
	DEV					
	ACTUAL					
	DEV					
	ACTUAL					
	DEV					
	ACTUAL					
	DEV					
	ACTUAL					
	DEV					
	ACTUAL					
	DEV					
	ACTUAL					
	DEV					

SEC III–OFF-SITE DATA
SECTION IV EVALUATION CRITERIA (Segment weight and other significant measure)

OUTSIDE DOLLARS PER UNIT	SUBCONTRACTED: % EFFORT PER UNIT	SUBCONTRACTED: DOLLARS AND % PER UNIT	MEASURE	ON-SITE FABRICATION	ALL OTHER OUTSIDE PURCHASE	SUBCONTRACTED	GFE	TOTAL
a	b	c	a	b	c	d	e	f
		$	SW					
		%	OSM					
		$	SW					
		%	OSM					
		$	SW					
		%	OSM					
		$	SW					
		%	OSM					
		$	SW					
		%	OSM					
		$	SW					
		%	OSM					
		$	SW					
		%	OSM					
		$	SW					
		%	OSM					
		$	SW					
		%	OSM					
		$	SW					
		%	OSM					
		$	SW					
		%	OSM					
		$	SW					
		%	OSM					
		$	SW					
		%	OSM					

SECTION V–FLOW TIME (Work days) (Last unit completed in third month of report quarter)

UNIT NO	STARTING DATE	COMPLETION DATE	ELAPSED TIME (Workdays)	% PERCENT DIRECT UNIT MAN HOURS PER TIME INTERVAL IN WORK DAYS: LAST (5) 30	(6-10) 31-60	(11-15) 61-90	(16-20) 91-120	(21-25) 121-150	26-30 151-180	181-210	211-240	241-270	271-300	301-330	331-360	OVER 360
a	b	c	d													

REMARKS (Enter on reverse side)

PREPARED BY (Name) (Title) (Date)
MAKE INQUIRY TO (Telephone No.) (Ext)
APPROVED BY (Name) (Title)

DD FORM 22 NOV 1957 (PROPOSED)

. . . plant capacity, production, will be required.

MISSILE MANUFACTURER'S PLANNING REPORT
PLANT AREA AND ELECTRICAL CAPACITY
(MMPR M-4)
(DUE DATES: 30 January and July)

FORM APPROVED
BUDGET BUREAU NO. ____
REPORT CONTROL SYMBOL
REPORT FOR SEMI-ANNUAL PERIOD ENDING

REPORTING PLANT
ADDRESS (Street, City and State)
PLANTS INCLUDED (Name and location)

SECTION I – USED AND UNUSED AREA BY OWNERSHIP (Square Feet)

LINE NO	ITEM	TOTAL AREA a	USED AREA b	UNUSED AREA c
1	TOTAL COVERED FLOOR AREA NOT LEASED TO OTHERS (Lines 2, 3, and 4)			
2	COMPANY OWNED AND NOT LEASED TO OTHERS			
3	LEASED FROM THE GOVERNMENT			
4	LEASED FROM PRIVATE OWNERS			
5	TOTAL PAVED YARD AREA (Company Owned or Leased from Others)			
6	COMPANY OWNED AREA LEASED TO OTHERS			

SECTION II – FLOOR AREA BY TYPE OF USE (Square Feet)

LINE NO	TYPE OF USE	CURRENT a	6 MONTHS FORECAST b	2 MONTHS FORECAST c
1	TOTAL (Used and Unused) (Lines 2 and 3)			
2	TOTAL UNUSED (Include Used Storage)			
3	TOTAL USED (Lines 4 and 5)			
4	USED INDIRECT			
5	USED DIRECT COVERED AREA			
6	A. MISSILE AREA (Lines 7 and 8)			
7	(1) ALL SEGMENTS			
8	(2) ALL OTHER MISSILE AREA			
9	B. NON-MISSILE AREA (Lines 10 and 11)			
10	(1) ALL OTHER MILITARY PRODUCTION			
11	(2) ALL OTHER NON-MILITARY PRODUCTION			

SECTION III – ELECTRICITY USE AND ELECTRICAL CAPACITY

	MONTH							
1								
2	KWH USED (000)							
3	KILOWATT CAPACITY (000)							

changes in the first three, they are pretty much what will be sent out. One of the areas of dispute between the industry representatives and the government representatives is the differentiation (if any) between "quality control" and "test and check-out." This also is one of the basic differences between the AMPR and MMPR forms: AMPR had no test and checkout column.

MISSILE MANUFACTURERS PLANNING REPORT
MISSILE SEGMENT
PRODUCTION SUPPORT AND TEST AND CHECK-OUT DATA
(MMPR M-1)
(DUE DATES: 30 January, April, July, and October)

FORM APPROVED
BUDGET BUREAU NO. ____
REPORT CONTROL SYMBOL
FOR QUARTER END NO.

WEAPON SYSTEM TITLE
WEAPON SYSTEM PRIME CONTRACTOR
MODEL IDENTIFICATION
SEGMENT – PRIME RESPONSIBILITY
CONTRACT NOS. (Continue on separate sheet if necessary)
COMPANY MAILING ADDRESS
REPORTING PLANT
OTHER PLANTS INCLUDED

SEGMENT(S) REPORTED
☐ GUIDANCE
☐ POWER PLANT
☐ STRUCTURE
☐ MATED SEGMENTS
☐ RECOVERY
☐ ARMAMENT
☐ CONTROL & MULTI-PURPOSE ENERGY SYSTEMS
☐ INSTRUMENTATION & MISCELLANEOUS
☐ _____

SECTION I – PRODUCTION SUPPORT

MONTHS		ENGINEERING: PRODUCT MAN-HOURS	ENGINEERING: PRODUCT % SUBCONTRACTED MAN-HOURS	MANUFACTURING: PROCESS MAN-HOURS	MANUFACTURING: PROCESS % SUBCONTRACTED MAN-HOURS	MANUFACTURING: TOOLING MAN-HOURS	MANUFACTURING: TOOLING % SUBCONTRACTED MAN-HOURS	QUALITY CONTROL MAN-HOURS	SHOP SUPERVISION MAN-HOURS	ALL OTHER MAN-HOURS
		a	b	c	d	e	f	g	h	i	j
0. LAST MONTH OF PREV QTR.											
REPORT QUARTER	1										
	2										
	3										
FORECAST	4										
	5										
	6										
	7										
	8										
	9										
	10										
	11										
	12										
	13										
	14										
	15										

SECTION II – FINAL TEST AND CHECK-OUT POSITIONS AND FLOW TIME (Last month of report quarter)
1. NUMBER OF POSITIONS USED
2. FLOW TIME IN WORK HOURS

The MMPR forms were developed by the Economics Division of Stanford Research Institute, under a contract with Army Rocket and Guided Missile Agency, in cooperation with the Navy Bureau of Aeronautics and the USAF Air Materiel Command.

The presiding (judging) group for final approval of the MMPR form is known as the Committee on Missiles, which works with the Bureau of the Budget. Companies with representatives on the Committee include General Dynamics Corp.; Raytheon Mfg. Co.; The Martin Co.; Westinghouse Electric Corp.; Aerojet-General Corp.; North American Aviation, Inc.; Convair; Chrysler Corp.; General Electric Co.; The Sanborn Co.; Douglas Aircraft Co.; Firestone Tire & Rubber Co.; Western Electric Co.; A.C. Sparkplug div.; Thiokol Chemical Corp.

MISSILE MANUFACTURER'S PLANNING REPORT
WORK SCHEDULE OF DIRECT WORKERS
(MMPR M-5)
(DUE DATES: 10 January, April, July, and October)

FORM APPROVED
BUDGET BUREAU NO.
REPORT CONTROL SYMBOL
REPORT FOR THE PAY PERIOD ENDING NEAREST THE END OF THE LAST MONTH OF REPORT QUARTER
FROM TO

REPORTING PLANT
ADDRESS (Street, City and State)
PLANTS INCLUDED (Name and Location)

SECTION I – WORK SCHEDULES OF DIRECT WORKERS

ITEM	1ST SHIFT (Day) ACTUAL: NUMBER OF WORKERS a	1ST SHIFT (Day) ACTUAL: DAYS PER WEEK PER SHIFT b	1ST SHIFT (Day) ACTUAL: HOURS PER DAY c	2ND SHIFT (Swing) ACTUAL: NUMBER OF WORKERS d	2ND SHIFT (Swing) ACTUAL: DAYS PER WEEK e	2ND SHIFT (Swing) ACTUAL: HOURS PER DAY f	3RD SHIFT (Night) ACTUAL: NUMBER OF WORKERS g	3RD SHIFT (Night) ACTUAL: DAYS PER WEEK h	3RD SHIFT (Night) ACTUAL: HOURS PER DAY i
1. MISSILE WORKERS BY PROCESS: A. FABRICATION									
B. ASSEMBLY									
C. TEST AND CHECK-OUT									
D. ALL OTHER									
E. TOTAL									
2. NON-MISSILE WORKERS									
3. GRAND TOTAL									

REMARKS (Note any significant changes in work schedules expected to occur during forecast period.)

PREPARED BY (Name) (Title) (Date) MAKE INQUIRY TO (Tel. No.) (Ext.)
APPROVED BY (Name) (Title)

DD FORM 22 NOV 1957 (PROPOSED)

Soviets Push Missile Plastics

by Alfred J. Zaehringer

Behind Nikita Khrushchev's recent call for more plastics production is seen the growing need for missile plastics. Only a small amount of plastics is now going into the civilian market. A large portion of the plastics production that is planned will go into vital military areas.

Prominent among these military applications will be plastics for missiles, rockets, and space flight ventures. In 1957, m/r reported on the cartel associations of the USSR, and the satellite countries' chemical industry, in particular, the vast new plants that were planned. Many of these are now in production, and a lion's share of the output is going into the missile field. Here are some informal estimates of plastics now being used in missiles:

1. *Epoxies.* 10-20 million lb/yr. Production in USSR, East Germany, Poland. Use for high-energy solid propellant fuel-binder. Most epoxies going into plastic tooling, glass-plastic laminates, and corrosion-proof coatings. Adhesives for honeycomb structures and metal bonding. Also vital in missile electronics potting compounds.

2. *Fluorocarbons.* Production at least 1 million lb/yr. in USSR. Much, if not all fluorocarbons going into atomic processing plants with small amount being fabricated into seals, etc. for liquid propellant rockets.

3. *Phenolics.* Production estimated at over 25 million lb/yr. Heavy emphasis on phenolic-glass-reinforced solid propellant rocket motors and components. Possibly also burn-away ballistic missile nose cones.

4. *Polyesters.* About 20-30 million lb/yr. May be used for fuel-binders, laminates and most assuredly for missile radomes.

5. *Polysulfides.* Perhaps 5 million lb/yr. Being de-emphasized for solid propellant fuel-binders.

6. *Polyethylene.* Unknown production. But ethylene oxide plants known to be in operation. Very limited missile use.

7. *Polyurethane.* Production is about 5-10 million lb/yr. Heavy use for fuel-binders, adhesives, seals, liners, and coatings. Little foam applications, unlike U.S.

8. *Silicone.* Production figures not known. High temperature missile laminates appear to dominate other applications.

According to Dr. Herman F. Mark, a world authority on polymer chemistry and Director of the Polymer Research Institute of Polytechnic Institute of Brooklyn, the Soviets have invested heavily in plastics research. Aside from production, Dr. Mark gives the following polymer research centers: Moscow, Leningrad, Baku, Tashkent, Charkov, Sverdlovsk, Kazan, Kiev, Novosibirsk, and Irkutsk. At these centers, Dr. Mark estimates the following levels of manpower at 60-80 full professors, 600-700 Ph.D's, and about 2,000 laboratory workers.

In general, the laboratories are as well equipped as in the West, and in some cases much more heavily stocked. Some of the research work in plastics and their significance to the missile field are related below:

Karpov Institute of Physical Chemistry, Moscow. Polymerization is kinetically studied. Monomers and related materials studied (butadiene, isoprene, and styrene) indicates interest in synthetic rubber fuel-binders and polyesters. Another group is studying the degradation of plastics under influence of heat and high intensity radiation. Of particular significance for ballistic missile warheads and effects of anti-missile weapons.

University of Moscow. Nobel prize-winner Semenov, who is working on free radicals, is interested in polymers. Thus, there may be the possibility of stabilizing free radicals by "tying them up" in plastics that could also be used in solid propellants. Another group is working on stresses in plastics, and the outcome could be better missile structures—possibly pre-stressing.

Institute of Element Organic Compounds. Prof. A. Nesmenov, president of the USSR Academy of Sciences and director of the Soviet satellite efforts, heads this research organization. Purpose is the synthesis of metal organics.

Institute of Macromolecular Chemistry. This group is vitally interested in "giant molecules" that make up synthetic rubber and the new plastics.

Institute of Oil and Coal Research. At work on high pressure polymerization; also turning out boron alkyl compounds.

Institute of Organic Chemistry. Particularly active in cellulose chemistry, now of vital importance in new homogeneous solids containing nitroglycerin and nitrocellulose. Russia produces 2.4 million tons of cotton per year, a vital cellulose source.

In conclusion, it can be stated that demands for plastics in missiles has skyrocketed in the USSR. Much time and effort has been invested in research, and now production is the important step. Last year, the *Sputniks* were considered spectacular by Western scientists. These gains were based on a plastic technology that was five years old.

Nike-Cajun Measures Humidity

Humidity in the upper atmosphere is being measured by a hygrometer installed in the nose of the IGY *Nike-Cajun* High Altitude Carrier Rocket. Secret of its operation is a lead sulfide cell.

Lead sulfide is photosensitive, so electrical reactivity of the cell is directly proportional to intensity of sunlight or radiation beamed on it. Intensity of sunlight, in turn, varies inversely as the amount of water vapor in the atmosphere between the instrument and the light source—the sun.

The proportionate change in output of the lead sulfide cell, which is telemetered back to earth, is thus a measure of the humidity of the rare outer atmosphere in which the rocket does its work.

Exposure of the cell to solar radiation is held constant by a sun-follower, an optical system that stabilizes attitude of the instrumentation with respect to the sun regardless of pitch, yaw or spinning motion of the rocket. The grating filters the sun's light into its components as to wave length. The collimator is a beaming device to focus



the reflected light on the lead sulfide cell in the nose of the rocket.

New Propellant Battleground: Aircraft-Carried Missiles

Liquid propellant motors have again entered into battle with solids—this time in the case of missiles carried by aircraft.

Efforts have been under way for some time to develop liquid pre-packaging methods for big birds like ICBM's and IRBM's, in order to build up their readiness. With the small missiles, however, the problem is not so much readiness, as it is safety and reliability.

In a word, aircraft performance threatens to outstrip missile technology. The problem is to develop a rocket motor that will withstand all of the environmental conditions that it may encounter from factory to firing, and yet still operate reliably when the firing button is pushed.

It is a problem of temperature—and is so critical that some aircraft may have to limit their combat performance when they are carrying today's air-to-air and air-to-ground missiles, such as *Sparrow III, Sidewinder, Falcon* and *Bullpup*. It is currently a solid-propellant problem, but pre-packaged liquids may take over if the temperature tolerance of solid propellant grains cannot be appreciably widened. It's both an on-the-ground climatic and an in-flight operational problem.

• **Mass production at stake**—Less than a million dollars a year is being spent by Navy, Army and Air Force on research for a solution. This is a small amount of money, but on the outcome rests a considerably larger volume of production and sales, for these are truly the "mass production" missiles. Both current and potential suppliers of both systems have a large stake in the battle. At the moment, virtually all missiles in these categories are solid-propellant powered, but the decision that may change all this is due in about 12 months.

Generally speaking, specifications for in-production solid propellant missiles call for the motors to be able to withstand from –65°F to +160°F without cracking of the grain, spontaneous ignition, warping, necking, or buckling. However, many motors become unsafe and unreliable after exposure to –40°F, or may blow up on firing at temperatures of 200°F or over.

Contrast these figures with, say, a typical combat mission by an interceptor taking off from Thule under winter conditions. The temperature on the ground may be –65°F. The plane takes off, climbs to 40,000 feet and flies for 15 minutes at Mach 2.2. Regardless of the adiabatic air temperature at that altitude (probably about –40°F), the effective temperature of the air passing over the aircraft skin and the skins of any externally slung missiles is on the order of 200°F or more. Then the missile is fired and has a peak velocity of, say, Mach 3.5. Aerodynamic heating temperatures may top 300°F.

The sharp contrast between the temperature on the ground and the high in-flight temperatures results in a double danger; first, that the missile motor may blow up at the moment of firing—due either to a damaged grain or simply to the heating—and take the wing of the plane with it; or, secondly, it may explode after leaving the launching aircraft before it achieves its mission. In either case, the problem is great.

• **Navy headache?**—It is more a Navy than an Air Force problem, since most of Navy's carrier planes sling their stores externally, while Air Force usually pods them. However, all three Services have an interest in improving the performance and tolerances of their small birds.

For the Navy, Aerojet-General has the prime responsibility for trying to improve solids, while the Reaction Motors Division of Thiokol Chemical Corp has been given the liquid task.

Generally speaking, the parameters of the desired system are a temperature tolerance of from –65°F to +300°F (though they'll take 240°F), and a specific impulse of something over the presently operational 200 seconds. The motor, whether it's solid or liquid, should not require fueling or internal inspection for a minimum period between two and three years. And, at that time, provision must be made for returning it to the factory for checking and inspection.

Solids already meet the inspection-free requirement. Liquids can cope with the temperature requirements. The problem is to make one or the other fulfill both sets of conditions.

The liquid approach to pre-packaging is relatively simple. There are no pumps and, in fact, only a couple of moving parts in the whole motor. Solid propellant pressurization is used. Standard materials make up the tankage. However, as in all liquid systems, control of propellant flow rates is a major headache.

The solution to the solid propellant's problem lies primarily in chemistry—development of a binder that retains its basic properties (flexibility) over a wider temperature range. Aside from the rocket companies themselves, both Shell Development Corp. and Sinclair Refining Co. are working towards such a binder. An additional problem, of course, is a propellant combination that will not spontaneously ignite in the higher temperature ranges.

Navy's Ordnance Test Station at China Lake demonstrated the feasibility of the pre-packaged liquid system when, several years ago, it developed and fired the *LAR* (Liquid Aircraft Rocket) successfully. This utilized red-fuming nitric acid and aniline. Propellants of this nature freeze at –65°F to –85°F, and are not generally bothered by the upper ranges under consideration.



Daniel Mann Johnson & Mendenhall

TRAINING FACILITY for power plant operation and fueling systems procedures for *Atlas, Titan* and *Thor*, to be erected by Air Training Command, Chanute AFB, Ill. Other facilities will be at Sheppard and Keesler AF bases. Project cost to be $11 million.

Senate OK's $40 Billion for Military

The Senate Appropriations Committee, in reporting out a $40.03 billion Fiscal Year 1959 Defense Department appropriation bill, last week upped the House total by $1,623 billion. The Senate version was also $1.24 billion more than that requested by the Administration.

(The bill must now be acted on by the whole Senate, and then go into a joint Senate-House conference to iron out the differences.)

The Department of Defense will get at least as much as it asked for, in all probability. The international situation being what it is, the inclination of the Congressional conferees will be to compromise upward, rather than down. Administration requests came to $38.8 billion, up $3.9 billion.

For Navy aircraft and related procurement, which includes missile funds, the Senate committee recommends $2.08 billion—$133 million more than the House, but $9 million less than was requested. Respective figures for the Air Force are $6.9 billion, plus $570 million and plus $472 million. Army would get $1.67 billion, which is $14.7 million more than the House-approved bill and $51 million more than the official request.

Recommended research and development appropriations come to a total for the three services of $2.063 billion, which is $86.2 million more than was asked for, and agrees precisely with the House-approved total. Like the House, the Senate committee recommendation includes funds for six *Polaris*-launching submarines, instead of the two asked for by the Defense Department. It also approved $11 million for speeding construction of three *Regulus*-launching submarines. This would go along with the House in adding $43.7 million to the *Polaris* Fleet Ballistic Missile program. Additional funds for *Minuteman* and *Houndog* passed by the House were approved in the report.

The Senate Committee recommends the appropriation of a $150 million emergency fund to the Department of Defense, plus a transfer authority of up to $200 million—$100 million more than that approved by the House—and far short of the $1 billion transfer authority requested.

• **Research urged**—Throughout its report, the Senate Committee strongly urged much greater concentration by all three services on basic research, as compared to applied research and development. The Committee spoke of "an absolute necessity (to do this) if we are to maintain a lead in the technological developments which will produce scientific supremacy a decade from now."

The Committee also had some words of warning for the Air Force: it called for "careful reappraisal in connection with the expenditure of funds appropriated by this bill . . . (since) AF has allowed duplicate testing facilities to be built by private contractors while permitting Government-owned facilities to remain idle."

Senators said they were "at a loss to understand the thinking behind the reduction made by the Air Force of highly trained technical and professional personnel in this selective area of space conquest . . . the committee notices a growing lack of energy in the AF in space activities, and strongly advises AF to survey its (R&D) bases with a view to utilizing one or more of these installations as a laboratory for space biology and biodynamics."

The committee also deplored rising costs of contracts with private industry: "The general lack of a pressing need for economical production, once competitive marketing is removed, is inimical to the public interest and weakens our defense armor."

The Defense Department was directed to make a study of this problem and submit a report on its findings by January 15, 1959. The Senate group also refused to go along with provisions to fund price differentials on contracts that are directed towards depressed areas. This will mean, if the deletion survives the conference, depressed areas will not get preferential treatment in the awarding of defense contracts unless their prices match that of the lowest bidder.





***JUPITER* AND *REDSTONE* ballistic missiles move down parallel production lines at the Warren Missile Plant of Chrysler. The number of *Jupiters* shown indicates quantity production is being achieved. A *Jupiter* tank assembly undergoes dynamic tests at the missile plant (right). The missile section has been lowered into a test pit below the floor level for this operation. Heavy presses and other production equipment used for manufacture of components can be seen in the background.**

Top m/r Coverage Planned For August IAF Meeting

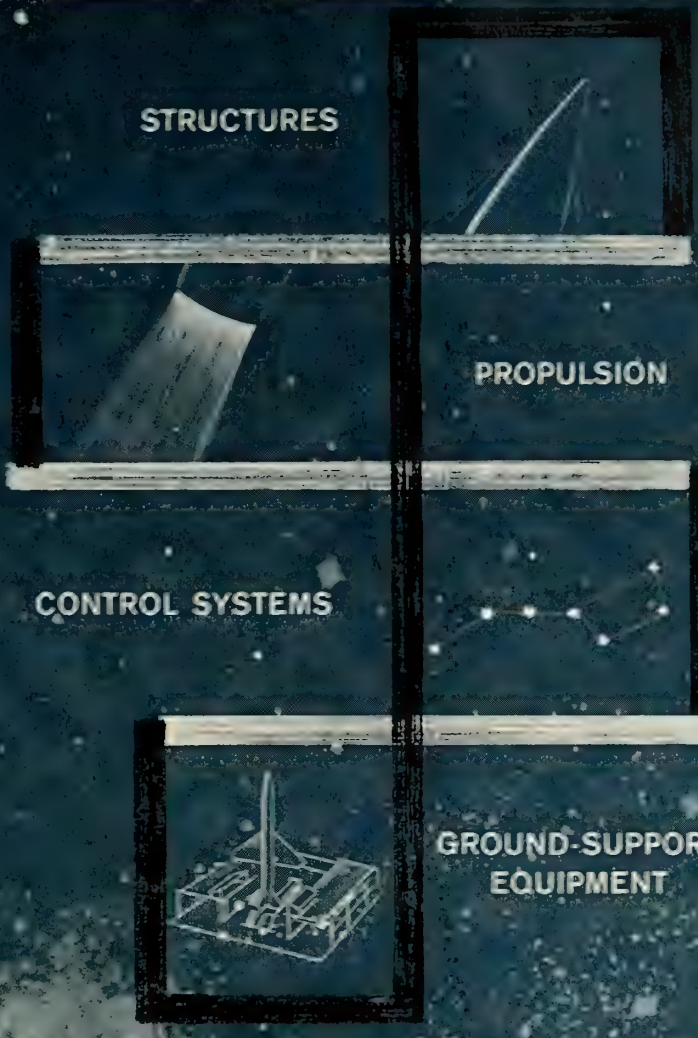
Following its policy of providing top news coverage of world events for its readers, Missiles and Rockets magazine will send two top editors to the Ninth Annual Congress of the International Astronautical Federation at Amsterdam, Holland, August 25-30.

Erik Bergaust, executive editor, and Anthony Vandyk, chief of American Aviation Publications' European correspondents, will attend the sessions and report on the meeting for m/r readers. Also, several of the magazine's contributing editors and members of its advisory board, including Dr. Wernher Von Braun, will attend the Congress, and will assist in preparing a full report.

Kincheloe's Standby Pilot Takes Place On X-15 Team

Captain Robert M. White has been named by the Air Force to succeed Captain Iven C. Kincheloe, Jr., as the AF member of the three-man team training to take the X-15 into space. Captain Kincheloe was killed July 26 when his F-104 jet fighter crashed while he was flying "chase" at Edwards Air Force Base.

Roll-out of the North American X-15 is expected about November 1, probably at Edwards AFB. First flight tests are slated for early in 1959. However, the Air Force is not expected to fly the X-15 for about a year.



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Thompson Products, Inc.

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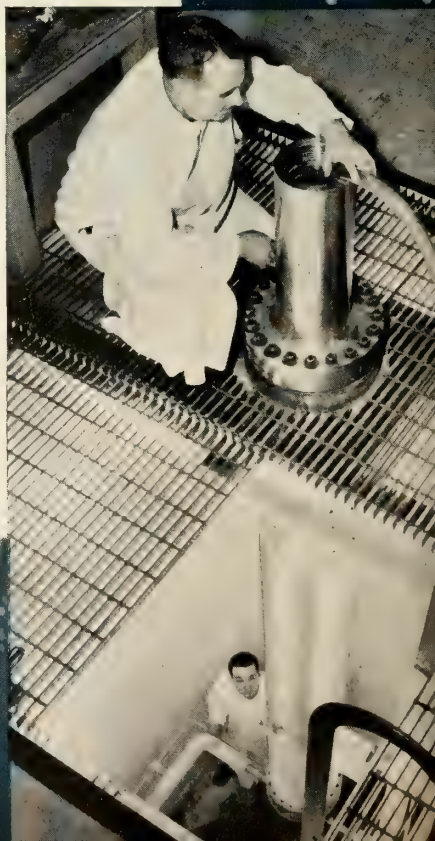
TAPCO INTEGRATED FACILITIES

provide components and assemblies for propulsion systems and complete auxiliary and accessory power sub-systems

Over 50 years of experience in developing metals and designing components for power plants gives the Tapco Group a vast experience in research, development and manufacturing of assemblies and components for propulsion and power systems and sub-systems.

Now, Tapco's capabilities have been broadened to include most phases of nuclear-power plants and accessories. Research is under way on the special metallurgical problems associated with radiation effect.

Fuels for all types of engines and power plants are collateral research projects at Tapco, where complete facilities for research and evaluation on solid-state, liquid and nuclear fuels are in existence.

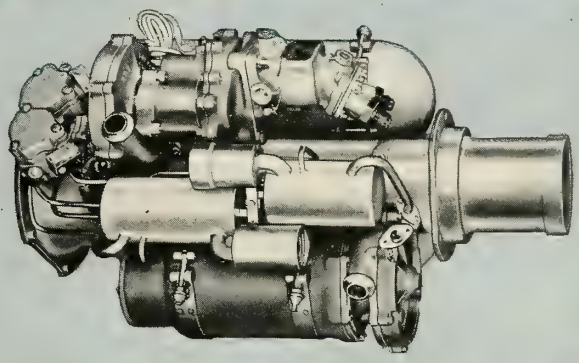


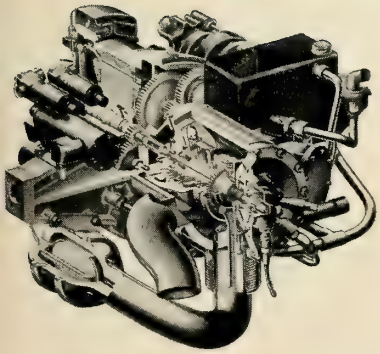
Function testing of nuclear reactor control rod drive mechanisms ▶ in a simulated vessel head; part of Tapco's continuing research project on nuclear reactor components and control systems.



◀ Special problems of forming, heat-treating, and resistance welding were solved at Tapco in producing this large weldment for jet engines.

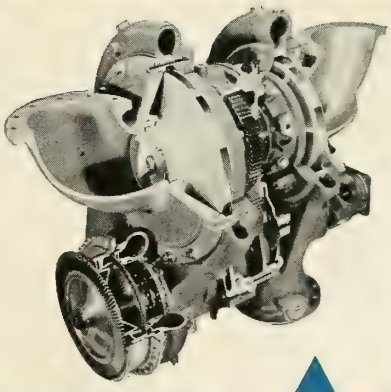
Self-contained solid-propellant auxiliary power unit designed and built at Tapco to produce electric and hydraulic power. ▼





At left: Combination main and afterburner engine-driven fuel pump now providing thousands of hours of trouble-free service in production fighter aircraft.

At right: Rocket engine turbo pump now in production at Tapco for use in several of America's leading missiles.



TAPCO GROUP

consisting of Accessories, Jet, Electronics, Pneumatics and West Coast Divisions

OTHER INTEGRATED SERVICES FROM TAPCO INCLUDE DESIGN, DEVELOPMENT OR PRODUCTION IN THE FIELDS OF STRUCTURES, ELECTRONICS, METALLURGY AND NUCLEAR POWER.

Thompson Products, Inc. CLEVELAND 17, OHIO



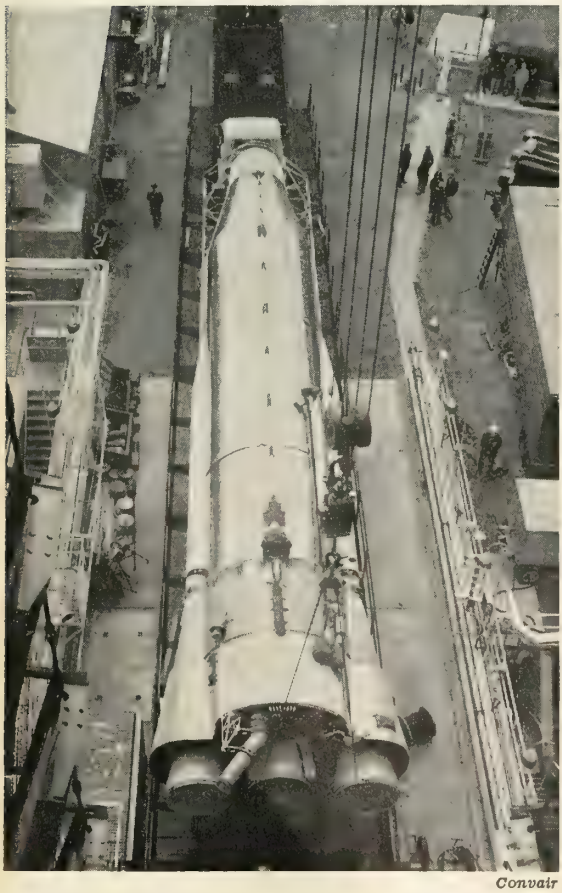
Convair



N. L. Baker

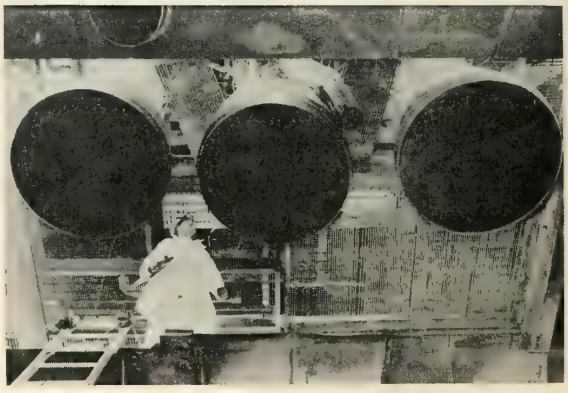
Convair-Astronautics recently dedicated its new $40 million Kearny Mesa plant near San Diego. The plant was constructed specifically for development and production of the *Atlas*. Officials who attended the dedication included (left to right): J. R. Dempsey, manager CA; Lt. Gen. C. S. Irvine; J. V. Naish; RAdm. Hartman; Maj. Gen. Wade; K. J. Bossart; Maj. Yokie.

ATLAS in the News



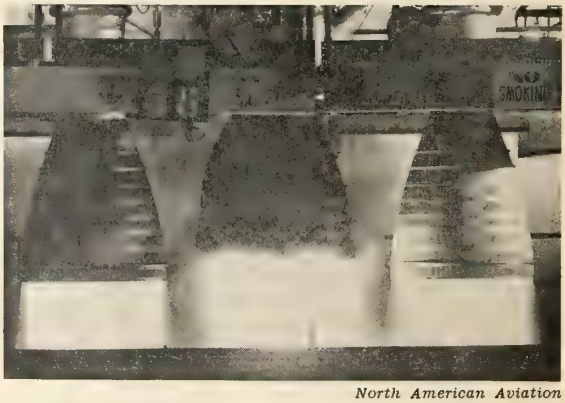
Convair

The engine cluster that will power the missile during its 5,500-mile flight is shown in this overhead view. The missile pictured was destroyed after forty-five seconds of flight.



North American Aviation

Engine cluster mounted on test stand at Rocketdyne's Santa Susana facilities. The primary units are boosters on the left and right. The sustainer unit is located in the center.



North American Aviation

The free world's most powerful engine system. In flight, each booster develops 150,000-lb. thrust for 140 seconds, while sustainer chamber develops 54-60,000-lb. for five minutes.



missile business

by Seabrook Hull

Watch ARPA. The Advanced Research Projects Agency right now is just feeling its way along, but by this time next year it will have clearly defined its "roles and missions" and should be in a position to execute them. Potentially, ARPA may be the number one starting point for a large volume of space-age business.

Meanwhile, ARPA's listening. Director Roy Johnson, Rear Admiral John E. Clark, Dr. Herbert York, Captain Bob Truax and others are spending a large portion of their time hearing proposals from the three military services and industry. Whenever possible any and all of the "top 35" in ARPA sit in on these presentations. For one thing, it's a good concentrated education in space-age talk, concepts and costs.

ARPA's budget is small—$520 million. But whether it's a contract to launch a moon probe costing millions; or a components improvement order to research and develop a better rocket motor casing or a space auxiliary power system for $100,000 or less—the knowledge and technical capabilities acquired in each case will give the contractor an edge over his competitors in getting future business in the field.

Also, ARPA's budget will grow. So will its control over other space-age budgets. Today's space flight costs are peanuts compared to what will follow. ARPA's future is roughly equivalent to that of the Soviet Academy of Science's Commission for Interplanetary Travel, and in that respect it should ultimately become one of the most important market factors in the field of astronautics.

If you have an idea for advancing America's space technology and you have that idea down in some kind of coherent form, make an appointment with ARPA. That's why they're there—to listen and sift through ideas and to pick the best for financial support.

Concern over big U.S. liquid propellant ballistic missiles as weapons systems capable of supplying this country with an immediate retaliation capability is mounting. The goal, of course, is missiles that will be off their launching pads and on their way within 15 minutes of the decision to fire. Otherwise, the assumption is, enemy missiles will wipe out launching sites first.

The minimum fueling and countdown time now is (theoretically) two hours, though this has never been achieved, even at Cape Canaveral, where there are a maximum of facilities. Much the same thing would be true of both *Titan* and *Atlas*.

Nor is the proposition of continually cycling fuel and oxidizer necessarily feasible. One of the missiles can't even have its LOX tanks topped off again if the countdown is delayed and too much is vented off. All of them have oxidization and freezing problems if the LOX remains in the tanks too long.

As an interim alternative, until solid propellant missiles come along, the suggestion is being kicked around that Fairchild's *Gander* might be a better missile for Europe. Largely plastic constructed, it provides a radar target that is one-tenth that of an F-86. Thus, even though it is subsonic, it could be virtually on top of its target before intercepion. Range: 2,000 miles. Payload: One megaton.

Big advantage: It can be readily manufactured in Europe, at a cost to the U.S. of less than $500,000 in special tooling.

contract awards

LAST MINUTE AWARDS

Navy gave $385,000 to the Martin Co. for "engineering studies" on a nuclear-powered seaplane . . .

Air Force gave $23 million to Laboratory for Electronics, Inc. for production of AN/APN-105 doppler type airborne navigation gear . . .

ARDC's Rome Air Development Center gave $12 million to General Electric for production of advanced long range search radar systems for air defense . . .

Consolidated Western Steel Division of U.S. Steel Corp. gave $300,000 to Siegler Corp. for producing components for the *Nike-Hercules* launching system . . .

Corning Glass Works received a military contract of $104,000 for establishing pilot plant facilities for production and testing of high stability glass capacitors.

DEFENSE DEPT.

By Military Petroleum Supply Agency:
Tidewater Oil Co. received $651,929 for rocket fuel.
General Petroleum Corp. received $672,427 for rocket fuel.

By Corps of Engineers, Office of the District Engineer:
Steenberg Construction Co. received $5,883,850 for construction of *Nike* installations.

By Pittsburgh Ordnance District:
Westinghouse Electric Corp., Micarta Division, received $63,190 for testcones.

By Corps of Engineers, Omaha District:
Sioux Falls Construction Co. received $467,000 for construction of rocket storage facilities & group O&T building.
M. A. Garland Construction received $754,569 for construction of underground missile storage, *Nike* site.
Peter Kewit Sons' Co. received $487,509 for construction of additional *Nike* facilities, conversion & paving.

By Engineer Division, New England Corps of engineers:
Plantation Construction Co., Inc. received $112,435 for construction of field unit integration facilities at seven *Nike* sites.

By Procurement Office, Aberdeen Proving Ground:
Harwood Engineering Co. received $25,580 for missile launcher assy-charger & vacuum pump.
M. B. Mfg. Co., a div. of Textron, Inc., received $27,943 for testing system automatic sine wave vibration.

By Ordnance District, Los Angeles:
Firestone Tire & Rubber Co. received $170,000 for engineering services related to *Corporal* missile system.
Gilfillan Bros. Inc. received $185,134 for engineering services related to *Corporal* missile system.
Genisco Inc. received $33,775 for accelerometer.
Firestone Tire & Rubber Co. received 2 contracts totaling $2,086,215 for surface-to-surface guided missile.
Gilfillan Bros. Inc. received $91,695 for telemetry and instrumentation packages; $465,030 for field engineering services related to *Corporal* missile ordnance guidance equipment; $27,646 for telemetry ground receiving equipment; $133,824 for replenishment requirements of spare parts for *Corporal* missile; $52,643 for modification kits for *Corporal* equipment; $26,939 for *Corporal* ground guidance control equipment, amplifier, electronic control.
Firestone Tire & Rubber Co. received $519,853 for field engineering services related to guided missile artillery.
Douglas Aircraft Co. received 2 contracts totaling $33,923,649 for launching area items; $53,600 for supplies and services relating to the *Honest John* missile; $557,716 for *Honest John* fin assemblies, containers, accessory items.

contracts

ARMY

By Ordnance District, Los Angeles:
Grand Central Rocket Co. received $26,736 for loading and delivery of 100 phase I loki boosters.

Radioplane Co. received 4 contracts totaling $2,380,808 for supplies and services regarding missile targets.

Rheem Manufacturing Co. received $365,589 for *Nike* warhead and fuze.

Radioplane Co. received $720,921 for target drones.

Grand Central Rocket Corp. received $81,935 for propellant development.

Aerophysics Development received $49,896 for *Dart* antitank guided missile.

Convair, a div. of General Dynamics, Corp. received $284,338 for feasibility study of red-eye system.

Nortronics, a division of Northrop Aircraft, Inc., received $976,000 for maintenance shop set for *Nike-Hercules*.

North American Aviation received 2 contracts totaling $173,864 for digital computer.

Giannini Plasmadyne Corp. received $210,704 for hyperthermal research tunnel development and transport property measurements.

California Institute of Technology received 3 contracts totaling $5,148,500 for engineering research and development regarding guided missiles, free rockets, materials and wind tunnel operation.

By Boston Ordnance District:
Bolt, Beranek and Newman, Inc. received $45,720 for research and development study.

The Hicks Corp. received $42,600 for warhead guided missile inert XM 15, complete with attaching hardware.

By Corps of Engineer, Office of the District Engineer:
Thomas W. Yoder Co. Inc. received $263,382 for construction of modifications and additions and conversion of tactical facilities at *Nike* sites.

By Ordnance District, Los Angeles:
Ryan Aeronautical Co. received $50,000 for drone support equipment.

Firestone Tire & Rubber Co. received $62,737 for decontamination kits and shop sets for *Corporal* missile system.

Douglas Aircraft Co., Inc. received $151,376 for *Nike* field change kits; $870,345 for flat bed missile booster transporter; $192,346 for launching area items.

Fruehauf Trailer Co. received $27,024 for flat bed missile booster transporter.

By Engineer District, Chicago Corps of Engineers:
Mayfair Construction Co. received $1,879,800 for construction of additional facilities at special AAA sites.

M. H. Wolfe & Co. received $1,689,003 for construction of facilities at special AAA sites.

Fruin-Colnon Contr. Co. received $5,372,850 for construction of facilities at special AAA sites.

NAVY

By Bureau of Aeronautics:
Motorola Inc. received $253,994 for evaluation models drone tracking system airborne and surface units.

Climax Molybdenum Co. of Michigan received $40,917 for development of refractory metal alloys.

Cook Electric Co. received $35,183 for study of temperature and stress distributions in bonded structural panels under transient thermal loading.

The Garrett Corp. received $111,931 for four wheel trailers for gas-turbine driven-ground support units.

Acme Precision Products, Inc. received $20,022 for linear actuator test stand.

General Electric Co. received $45,954 for study for water depth determination using pulsating light technique.

Radio Corp. of America received $30,474 for study of applying advanced techniques to an airborne electronic commutator.

Bausch & Lomb Optical Co. received $56,568 for modifying government-owned rectifier to provide automatic dodging and exposure control.

University of Pittsburgh received $36,787 for conducting test on avionics equipment and parts.

Air Products, Inc. received $632,558 for liquid oxygen generator plants in accordance with specifications.

Resin Research Laboratories, Inc. received $44,414 for research and development of improved heat resistant, steospecific resins and adhesives.

Syracuse University received $100,340 for conducting research program to determine effects of stress concentrations.

Allen B. Dumont Laboratories, Inc. received $357,114 for development of meteorological radar set.

Owens-Corning Fiberglas Corp. received $33,290 for properties of fiberglass at elevated temperature.

Chance Vought Aircraft, Inc. received $77,817 for flight capsule feasibility study.

Westinghouse Electric Corp. received $262,349 for development of heat resistant alloys, with the objective of developing materials for use in gas turbine engines and other components subject to extreme heat.

Grumman Aircraft Engineering Corp. received $36,842 for conducting a study to design and develop an inflight thrust measurement system for turbo-jet powered aircraft.

Air Products Co. received $69,229 for pressure suit ventilating units.

Greer Hydraulics, Inc. received $68,245 for study to determine the optimum equipment and arrangement required for installation in a hydraulic pneumatic maintenance van.

Food Machinery and Chemical Corp. received $186,501 for hydrogen peroxide service vehicle.

Crucible Steel Co. of America received $419,848 for improved titanium alloy sheet.

By Bureau of Ordnance:
Autonetics, a division of North American Aviation, received $6.7 million for designing and fabricating the system which is regarded as the key to the successful launching of Polaris-type fleet ballistic missiles.

By District Public Works Officer, Eighth Naval District:
Pitman Construction Co. received $133,000 for A.N.G. rocket storage checkout and assembly building.

By Naval Training Device Center:
Joanell Laboratories received $86,000 for design, development and production of *Nike* handling trainers.

Guardite Co. received $413,488 for design, development and erection of altitude training rapid decompression chamber; $216,861 for development, construction and installation of rapid decompression chambers.

AIR FORCE

By HQ, Cambridge Research Center, ARDC:
The Perkin Elmer Corp. received $98,700 for optical system (to be incorporated in satellite tracking camera).

Boller and Chivens, Inc., and Joseph Nunn and Associates received $195,000 for satellite tracking camera.

Aerojet-General Corp. received $112,861 for studies, testing and services in connection with rockets.

Polytechnic Institute of Brooklyn received $225,000 for theoretical and exploratory research in electro-magnetics networks and related solid state and plasma topics.

International Business Machines Corp. received $186,000 for design and analysis of high-speed computer circuits.

General Electric Co. received $26,993 for services and facilities for tracking satellites; $47,953 for feasibility study of the use of phase reversal keying.

Lockheed Aircraft Corp. received $37,988 for research of the absorption coefficients of hot gases for the analysis of nuclear fire balls and other high temperature sources.

Stanford Research Institute received $114,000 for research on radiation effects in magnetics and dielectrics.

Stavid Engineering, Inc. received $200,883 for research directed toward the installation, testing and development of Badge experimental equipment.

Melpar, Inc. received $41,760 for research on anti-jam communication systems using redundant transmission.

By San Antonio R&D Procurement Office, Wright Air Development Center, ARDC:
University of Rochester received $30,915 for additional research & reports on oxygen poisoning.

HQ, Ogden Air Materiel Area:
Del Mar Engineering Laboratories, Inc. received $1,129,983 for scorer, radar-optic, 2.75 rocket types SXU-1/A and SXU-2/A.

By HQ, Mobile Air Materiel Area, Director of Procurement:
Mercantile Paper Co., Electronics Div., received $123,785 for installation of a complete closed circuit monochrome T.V.

New Metals Enter Market For Missile Applications

A series of new metals and production methods has emerged from various laboratories to aid the missile industry.

General Electric has introduced a high-temperature alloy, trademarked René 41, designed for use in jet engines and structural members. The nickel-base, titanium-aluminum hardened alloy can be formed, welded and machined with relative ease in comparison to other metals intended for use in the 1,800°F temperature range.

According to GE, the new metal can be welded without problems. It can be inert-arc welded with or without filler material, and also offers strong, ductile spot welds. Welds strongly approach the strength of the base metal.

National Research Corp. has achieved commercial production of very high purity tantalum metal. As part of the research program which brought about the possibility of producing the metal in large quantities, NRC also developed a new type vacuum arc-melting furnace for conversion of tantalum powder to large high-density ingots. The firm is now producing 30,000 lbs. of tantalum annually.

Metal Hydrides Inc. has introduced two new grades of high-purity zirconium hydride for the nuclear industry (MHI Grade R) and for commercial applications (MHI Grade C). According to the company, the latter, intended for use in such applications as electronics, pyrotechnics and related fields, is superior to zirconium metal as a getter in electronic tubes because it does not oxidize during seal-in or exhaust operations.

Martin's New Computer To Test Missile Data

One of the most advanced analog computing systems ever developed has been installed at the Martin Company's new guided missile and electronic facility at Orlando.

Called GEDA A-14, the system, which weighs five tons, is digitally controlled and is housed in a series of console cabinets extending 40 feet.

Goodyear Aircraft, a supplier of analog computing equipment for more than ten years, designed and produced the system to Martin specifications, and completed its installation at Orlando within a 13-month period. The company was awarded the contract following design competition with five analog computing equipment vendors.

Martin's GEDA A-14 is programmed and controlled digitally through the keyboard of an electric typewriter or punched paper tape.



Venus, in blue light. 200-inch Palomar telescope.

SPACE FLIGHT and NUCLEAR PROPULSION

A drastic reduction in vehicle mass ratios... substantially increased specific impulse values... a capability for achieving very high speeds... these are some of the significant advantages that will come from the application of nuclear energy to space flight.

A number of different propulsion systems have been proposed to utilize nuclear reactions. The simplest system consists of a fission reactor through which the propellant is passed, heated, and then expanded through a rocket nozzle. Fission reactors can also be employed as a source of energy to generate electric power, which in turn can be used to accelerate ions or charged particles, or to create and accelerate a plasma. And fusion reactors, when developed, can be used to generate electric power for the same purposes. In addition, in the case of the fusion reactor, there is the attractive possibility that the reaction energy can be used directly without conversion to electric power.

The fission-powered thermal propulsion system will probably constitute one of the next major advances in space technology. As an example of the gain which can be achieved, consider a vehicle with a payload weight of about 25 tons for a manned flight to one of the nearer planets, landing, and returning. Powered by chemical rocket engines, the takeoff weight for such a vehicle would be 50,000 tons. But powered by a fission-thermal propulsion system, weight at launch would not exceed 500 tons... a 100-fold reduction in the mass ratio. Considerably greater gains are predicted for the more advanced systems.

Systems studies and advanced research in the application of nuclear energy to the requirements of space flight are in progress at Space Technology Laboratories. This work illustrates the emphasis at STL on the exploration and development of new concepts and techniques in ballistic missile and space technology.

Both in support of its over-all systems engineering responsibility for the Air Force Ballistic Missile Program, and in anticipation of future system requirements, STL is engaged in a wide variety of analytical and experimental research. Projects are in progress in electronics, aerodynamics, hypersonics, propulsion and structures.

The scope of activity at Space Technology Laboratories requires a staff of unusual technical breadth and competence. Inquiries regarding professional opportunities on the STL Technical Staff are invited.

SPACE TECHNOLOGY LABORATORIES

A Division of The Ramo-Wooldridge Corporation

5730 ARBOR VITAE STREET • LOS ANGELES 45, CALIFORNIA

Complex Weapons Tough For Small Firms

by Frank G. McGuire

The downward trend in the amount of defense contracts awarded to small business is a result of the increasing complexity and costliness of modern weapons systems, according to Defense Department spokesmen.

Testifying before a Senate procurement subcommittee, military and civilian procurement officials cited the problem of complexity and said that only the larger contractors can handle the latest systems. They noted that even large firms have had to team up to take care of some jobs.

Sen. George A. Smathers (D-Fla.) commented on the DOD opening statement by saying, "the Defense Department usually makes nice statements, but statistics often fail to back them up." Thereupon, the committee counsel ticked off the percentages of total procurement awards to small business in the past eight years:

1951—20.9%	1955—21.5%
1952—17.0%	1956—19.6%
1953—16.6%	1957—19.8%
1954—25.3%	1958—16.2% (11 mos.)

"This," the committee charged, "is hardly an 'upward trend' in procurement awards to small business."

The Air Force's procurement awards to small business in the first 11 months of fiscal 1958 were 6.4% of the total for that period. The comparable figure for fiscal 1957 was 8.2%.

According to Air Force spokesmen, Air Force contracted for $1.7 billion more in the first 11 months of fiscal 1958 than in the entire 12 months of the preceding fiscal year. Because of this huge increase, they said, participation of small business dropped.

Air Force officials commented that they are not at all complacent about the drop, but added that each year there has been an increase in the actual number of dollars awarded to small business participants, and "it is with dollars that payrolls are met."

Army procurement officials noted that although the small business is at a "distinct disadvantage" in bidding on prime contracts for the modern weapons system, the Army has attempted to influence its prime contractors to let out the maximum in subcontracts.

During 1957, they stated, small business firms received $80.9 million from prime contractors as first tier subcontractors. This represents 14.4% of the total defense contract receipts received by prime contractors during July-December, 1957.

The prime contracting situation as concerns small business was shown in better light. Of the total prime contracts awarded by Army, 35% of the dollar value went to small firms—or 79% of the contracting actions involved.

The apparent large discrepancy in Air Force/Army procurement awards to small business is due to the nature of the items procured, and the tremendous complexity of Air Force equipment.

Industry Directed To Aid Future Engineers

Defense Secretary Neil McElroy's directive ordering the military to cooperate in youth science education, and assuming responsibility for the program, contains a section calling for industry participation.

The Defense Department's "expectation" that industry will participate in the program is taken as a sign that the government expects its contractors to help train future engineers, scientists, and other technical personnel.

Such assistance would take the form of making facilities available, providing lecturers, and other cooperation. Most likely to emerge as a formal organization is the "Youth Science Corps," suggested by the executive director of the Association of Missile and Rocket Industries, Kendall K. Hoyt, and presented to Congress by Sen. Edward T. Thye (R-Minn.).

Present military reserve facilities would be made available under the proposed plan; including classroom facilities, training films, safe demonstrations, and visits to defense installations such as *Nike* sites.

Moon Probe Shot Due By AF In Mid-August

August 14-19 appears to be a likely date for the Air Force to make its first lunar probe attempt, using *Thor* as the booster vehicle.

The Defense Department's Advanced Research Projects Agency declines to confirm or deny these dates. However, it is understood, barring any unforeseen setbacks in the program, that an attempt will be made at that time.

ARPA plans to have the press present for the shoot from Cape Canaveral, but will attempt to insure no advance publicity in case of failure.

Indian Head Begins Rehiring Personnel

The Navy has indicated that 117 persons have been hired at its Indian Head, Md., powder factory. The plant was recently the subject of an investigation by a Congressional committee looking into charges that the Navy paid Aerojet-General several millions of dollars for solid-propellant production facilities, while ignoring its own plant at Indian Head.

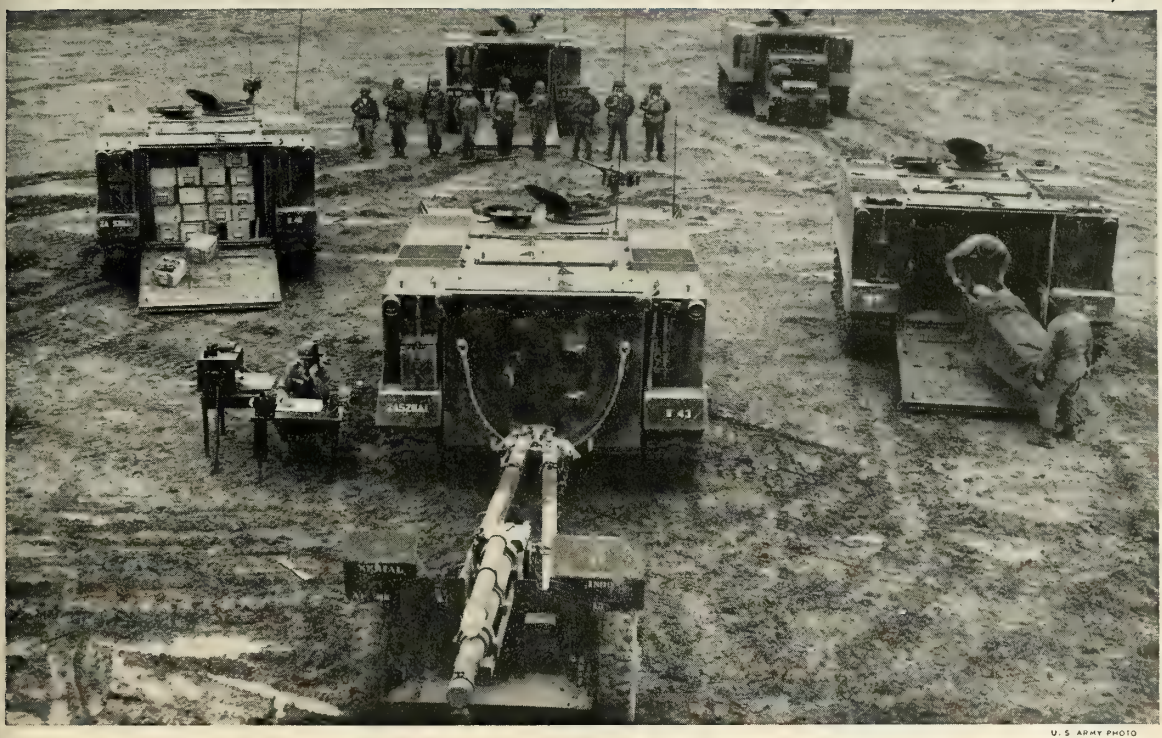
Rehiring of the personnel is seen as an indication that some solid propellant work is being undertaken at Indian Head.



AMERICA'S FIRST B-52G missile platform bomber rolled off the production line in Boeing-Witchita recently. This new type of B-52 will carry a GAM-77 *(Hound-Dog)* missile under each wing. Reported range of the missile, now under development by North American, is 300-400 miles with the capability to fire at two different targets simultaneously. The long-range air-to-surface missile will allow the B-52G, with its own increased range, to fire at targets now impervious to attack because of their distance from launching sites.

...speaking of

Missile Ground Support **MOBILITY**



U. S. ARMY PHOTO

WE DESIGN WITH STANDARDIZATION IN MIND

For example the FMC-designed M59 Armored Personnel Carrier was produced as a multi-purpose vehicle using many standard Army Ordnance components. This vehicle, designed in 1951, is still being produced for the Army. FMC is now developing a whole new family of military vehicles with a brand new concept. Substantial cost savings are anticipated based on standardization of many components.

The ability to design, engineer and produce mobile equipment based on standards already worked out can be applied to missile ground support equipment, providing lower costs for your program. Perhaps we already have a solution to your missile ground support equipment problem. *Consult with FMC at the initial stage of project planning.* Write today for more information.

Creative Engineers: Find stimulating challenge at FMC's Ordnance Division

FMC'S MISSILE SECTION IS IDENTIFIED WITH:

HAWK	Mobile loader vehicle
THOR	Transporter-erector and power control trailer
REDSTONE	Tracked prime mover
NIKE-HERCULES	Shipping and storage containers
BOMARC	Erector-launcher and Decontamination system
NAVAHO	Transporter-erector and vertical access tower

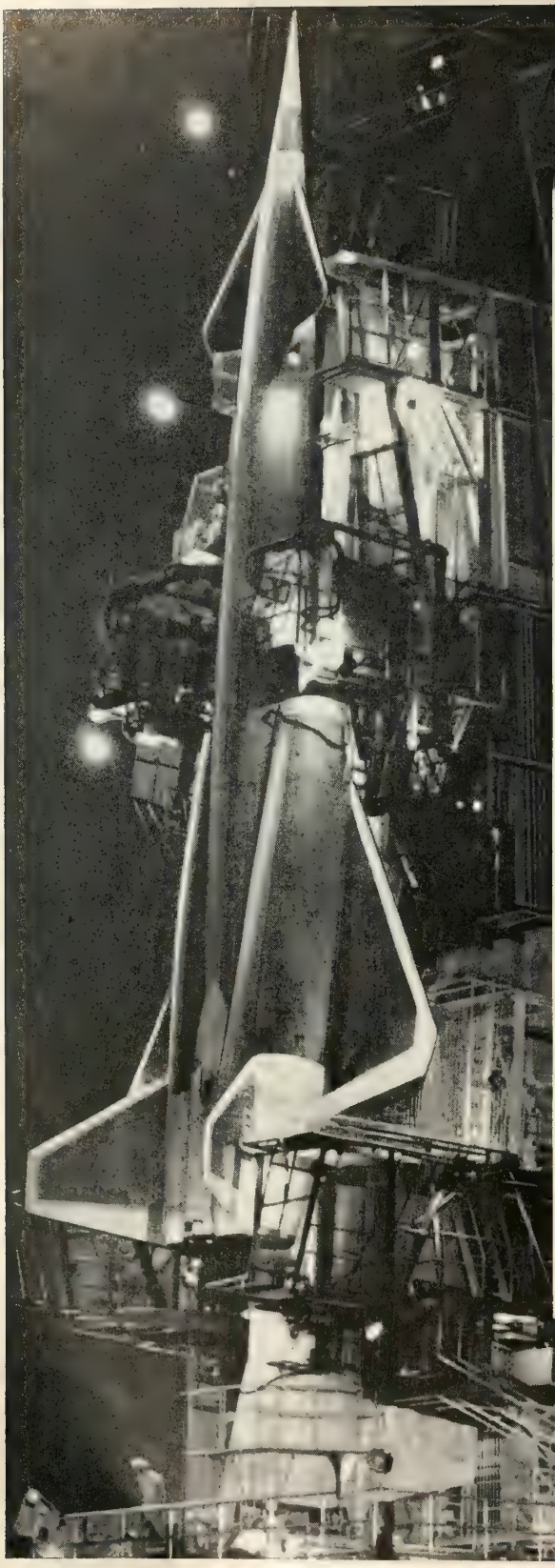
Putting Ideas to Work

FOOD MACHINERY AND CHEMICAL CORPORATION

Ordnance Division

Missile Equipment Section 1-D

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We have more GSE* experience than anyone

...and now we can put it to work for you

***Ground Support Equipment—mainstay of modern weapon systems**

A strong statement? Yes. But we can back it up.

We were the first company to have complete responsibility for a major supersonic missile weapon system. The Navaho—America's pioneer long-range missile—produced such a wealth of technological data that the entire missile program now draws on it.

Ground support equipment for the Navaho and the X-10 developed a new concept for checkout trailers, engine run-up dollies, instrumentation checkout consoles, hydraulic servicing units, ground power units, jet engine starters, ground cooling carts, ground hydraulic power supplies, ground pressurization equipment, ground fire-fighting equipment, access and support stands, air transportation dollies, and a wide range of other test and launching equipment.

This was done through the ability to integrate numerous single elements into complete, smooth-running ground support systems.

Specialized engineering and production skill and facilities in this new field are available to do an outstanding job for you, quickly and economically—on individual items or complete, coordinated ground support systems—either military or commercial.

Interested? Write or call Manager, Special Products, Missile Division, North American Aviation, 12214 Lakewood Blvd., Downey, Calif.

MISSILE DIVISION

North American Aviation, Inc.



propulsion engineering

by Alfred J. Zaehringer

It will take 5-10 minutes for AEC's atomic rocket engine to come up to full thrust. Reason: it can't come up to full pile temperature and then dump the working fluid all in the period of a few milliseconds. As the pile heats up, the coolant working fluid will have to be pumped through and exhausted. Working at low pressures, almost no thrust will be developed during the first minute or so while cooling takes place.

Best bet is that hydrogen will be used as the working fluid and coolant. For cooling, sweat or film cooling may be used in the hot parts. Except for ground static tests, regenerative cooling may not be used. First test atomic rocket motor will have a thrust of 5-50,000 pounds. First run-up will be in a few weeks. Incidentally, thrust-to-weight ratio of conceivable atomic engines will be inferior to chemical rockets.

Storable, safe, high-energy liquid monopropellants are in the works at Wyandotte Chemical. Hope is for an I_{sp} of over 300 sec in "Fuel-X." Practical conditions, however, will limit the liquids to 240-260 seconds. Trade talk is that Wyandotte's approach is through organic synthesis, and may be based on ethylene or propylene oxides as the starting point. The firm is already making a cellulose perchlorate for solid propellant use.

Olin Mathieson may enter the fluorine oxidizer picture. OM is already producing HF at its Joliet, Ill. plant. HF is the first step in the preparation of elemental fluorine. OM may enter as an oxidizer producer to sell fluorine-hydrazine propulsion systems. NACA calculates that the maximum I_{sp} for such systems would be about 315 seconds at a chamber pressure of 300 psi, and an exit pressure of 1 atmosphere.

The third boron fuel pilot plant is undergoing tests before production begins. The plant was designed and constructed by AFN (American Potash, Food Marchinery, and National Distillers), and is under the sponsorship of the Air Force. Located at Henderson, Nevada, the plant will produce a new alkyl borane.

It had previously been announced that the Henderson lab work was concerned with decaborane for solid propellants. The announcement raises the speculation that this will be the first plant to produce a boron fuel additive or polymer for solid propellants. Callery Chemical and Olin Mathieson are also operating pilot plants for the borons, in addition to large-scale facilities for aircraft boron fuels.

Triple-bonded compounds are being investigated as new fuel ingredients. Acetylene is already under observation, as are the substituted acetylenes (viz., methylacetylene) and other alkynes.

Effects of sound waves on chemical reactions will be under study by Aeronutronic Systems, at its new aerothermochemical laboratory at Newport Beach, Calif. The Ford subsidiary will pay particular attention to combustion reactions involved in new propulsion systems.

Aircraft, Missile Firms Rate High in "Top 500"

Twelve firms which are heavily in the missile field are included in FORTUNE magazine's latest listing of the 500 largest U.S. industrial corporations.

Top firm during 1957, from the standpoint of sales, was Boeing Aircraft, which, with $1.6 billion in sales, rose from 32nd among all companies in 1956 to 19th in 1957. Top company in 1956 was Douglas in 27th place, but 1957 figures show it as 33rd, with $1.09 billion in sales.

Thirty-seven companies in the U.S. reported sales of over $1 billion for 1957. These included Boeing, General Dynamics, North American and Douglas. A newcomer to the group was North American. Greatest jump in standings among missile companies was Chance Vought, which went from 303rd place to 183rd.

Among the companies in the missile field in the top 50 in sales were Boeing, General Dynamics and North American, who were rated in the top 50 most profitable firms.

Other firms changing position on the list: Lockheed, from 47th to 44th; Bendix, from 65th to 51st; Martin Co., from 103rd to 91st; Bell, from 185th to 208th; Fairchild which held close to steady, from 261st to 262nd.

Brooklyn Polytech Offers Space Curriculum

A new curriculum leading to a master of science degree in astronautics or space technology has been inaugurated by the Polytechnic Institute of Brooklyn.

Developed as a joint project of the departments of aeronautical engineering and electrical engineering, the curriculum will be offered in September 1958.

The new option will require 34 graduate credits, which is two more than is generally required for the master's degree. Courses will include Minimal Principles of Structural Analysis I and II; advanced Calculus I and II, Viscous Compressible Flow; Supersonic Flow; Hypersonic Flow; Mechanics and Thermodynamics of Real Gases; Dynamics; and Space Medicine.

In announcing the new curriculum, Dr. Antonio Ferri, head of the department of aeronautical engineering and director of the aerodynamics laboratory, noted that "to exploit, develop and support activities in space technology requires engineers with sound fundamental and science-oriented graduate training." To this end, Dr. Ferri said that the Department of Defense was "vitally interested" in encouraging Polytechnic's program.









Staff photos by Baker

Enthusiastically describing their latest satellite success are the top members of the *Explorer* team. Those present were Prof. Oberth, Dr. Froehlich, Dr. Pickering, Adm. Clarke, Gen. Colby, Gen. Barkley, Dr. Von Braun, J. Boehm, and S. Spear, USAF.

Army Does It Again:

Third *Explorer* Satellite In Orb
Three More Shots Authorized

by Norman L. Baker

CAPE CANAVERAL, FLA.—The Army satellite team has again demonstrated its "rocket know-how" by its ability to meet almost impossible schedules with admirable results.

Last week's launch of *Explorer* IV was the fourth attempt for the Army and the third success. It was also the first satellite launching to be sponsored by the Advanced Research Projects Agency, in line with its managerial position for all Department of Defense space projects.

Rear Admiral John E. Clark, deputy director of ARPA, announced, after *Explorer* VI's orbit was confirmed, that the Army has been authorized to make three additional satellite shots. At least one—and perhaps all three—will be fired over a northeast course. The new Army satellite will include an inflated aluminum balloon for visual observation, one for cosmic ray measurements, and another for further radiation belt investigation.

ABMA received the go-ahead for the *Explorer* IV satellite shot during the last week of May, after evaluation of the transmitted data from *Explorer* III.

Launch time had been previously set for 8:00 A. M. July 26. This was postponed by a matter of two hours, with pad lift-off occuring at a few seconds before 10:00 A. M. Dr. Jack E. Froleick, JPL project director, noted shortly after launching that this "X-O" time was only 17 minutes short of the optimum launch time. Last countdown hold was called at X minus 40 minutes. When resumed, the count continued through to ignition without further delays.

One hour and 30 minutes of the two-hour delay was due to a re-check of the radar link between the satellite vehicle and ground tracking stations.

The new northeastern launch direction required maximum coordination between Cape Canaveral ground tracking stations and the rocket, due to danger to the eastern seaboard from jettisoned parts of the launching vehicles. The course selected was the northernmost that could be used without going over U.S. land areas.

All sea lanes under the flight path were cleared hours before launch to prevent a million-to-one chance of danger to vessels. The main-stage *Redstone,* and the 14 rockets of the second and third stages should have fallen into the sea southeast and northeast of Cape Hatteras, respectively.

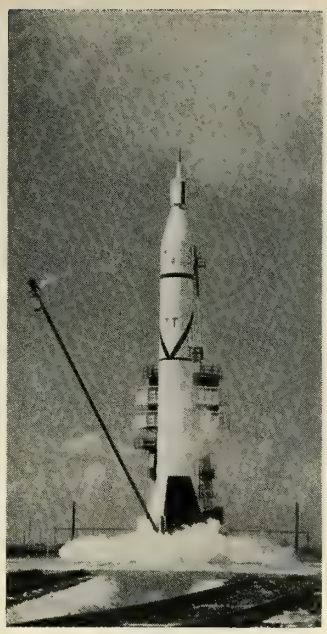
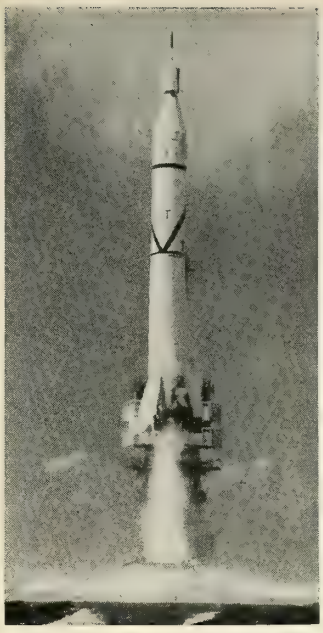
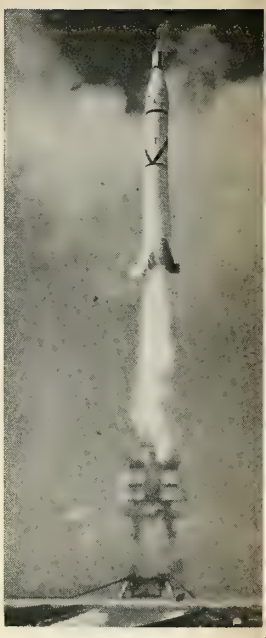
• **Radiation study**—*Explorer* IV was designed for an intensive study of the corpuscular radiation belt detected by *Explorer* III. The new orbit, which will take the satellite to 50.82 degrees latitude, was chosen to provide radiation data from areas in space not yet sampled (m/r, June, '58, p. 34). This orbit brings the satellite nearer the polar areas, a valuable area of exploration for studying magnetic field-corpuscular radiation relationship.

Explorer IV, consisting of payload and the final-stage rocket motor, is heavier than I and III, but identical in size and configuration. Payload weighs 25.76 lbs. with a total satellite weight of 38.43 lbs. Earlier *Explorers* had a payload weight of 31 lbs. The added weight in IV is in instrumentation, and was made possible by improvements at JPL in the solid propellants of the final two stages of the *Jupiter*-C vehicle.

Instrumentation includes two Geiger Mueller tubes and two scintillation counters to measure cosmic ray intensities.

The tubes and counters are designed to measure a wide energy spectrum. One of each is shielded to eliminate data below certain energy levels, and the unshielded scintillation counter's data is directed into two radio channels reporting different levels of energy. Two radio beacons with continuous transmission relay data over 5 common channels. One radio operates on 108.00 Mc, the other on 108.03 Mc.

Earlier *Explorers* reported only the gross amount of radiation encountered, while *Explorer* IV's instruments will record not only the total number of energy particles, but also what fraction of this total falls within certain preselected energy levels. It is suspected that only a very small number of the particles counted in the radiation belt previously were caused by high energy particles and identified as cosmic rays. Now, in *Explorer* IV, the shielded counters will respond only to high en-

Department of Defense photos

. . . ignition! *Explorer* IV Begins Journey Into Space

ergy particles while the unshielded counters will record all particles.

• **Communications tracking**—A communications network, involving 10 Microlock tracking stations located in and along the east and west coast, provided much of the early data on the performance of the *Jupiter*-C launching vehicle and the satellite.

The Army tracking stations are located at Cape Canaveral; Redstone Arsenal; Fort Monmouth; Van Buren, Me.; Aberdeen; White Sands; Cedar Rapids, Ia.; NOTS; Camp Irwin, Calif.; and Temple City, Calif. JPL and ABMA cooperated in setting up the Microlock ground radio network.

The NRL's Minitrack network is also receiving telemetered data from the satellite.

Adm. Clark headed a group of key defense leaders present for the countdown and launching. Included in the group were Brig. Gen. J. M. Colby, Deputy Commanding General of the Army Ordnance Missile Command; Brig. Gen. J. A. Barclay, Commander of ABMA; Dr. Wernher von Braun, Director, Development Operations Div., AMBA; Dr. W. H. Pickering, Director of JPL, Dr. Ernst Stuhlinger and Prof. Hermann Oberth, ABMA Research Projects Lab.; Dr. Walter Haeusserman, Director, ABMA Guidance and Control Lab.

Thirteen congressman were also present to witness the firing. They were accompanied by Maj. Gen. W. P. Fisher, chief of Air Force legislative liaison.

DOD Outlines Monitoring To Check Contractors

A new reliability monitoring program to supplement contractors' regular reliability monitoring activities has been recommended by an ad hoc committee and approved by Guided Missile Director William M. Holaday.

The report pointed out that a significant number of guided missile weapons systems have failed to meet the required standards insofar as both time-schedule and estimated costs.

The reliability monitoring system is based on the premise that reliability can be "quantitatively specified, estimated, assessed or measured at predesignated steps or monitoring points and that it can be controlled throughout the phases of design, development, production and major product improvement".

The committee visualizes increased costs in implementing the system, but anticipates savings in both time and money in attaining the desired performance and reliability. Additional savings are seen in the reduction of indirect costs in maintenance and maintenance training, spare-parts inventories, programs for material surveillance and product improvement and use of guided missile range facilities.

The first of the eight monitoring steps is implemented when the contract is awarded. The eight points may be varied or omitted to fit the nature of the particular program, and are designed to supplement rather than replace the contractor's own system.

The monitoring points are: (1) Detailed design study, (2) Preprototype, (3) Prototype, (4) Preproduction demonstration, (5) Demonstration of service readiness, (6) Service evaluation, (7) Full-scale production, (8) Demonstration of major product improvements.

It was the conclusion of the committee that reliability can be measured and controlled during all phases, that such a system is feasible during the growth cycle, and that the system will greatly increase assurance of adequate reliability.

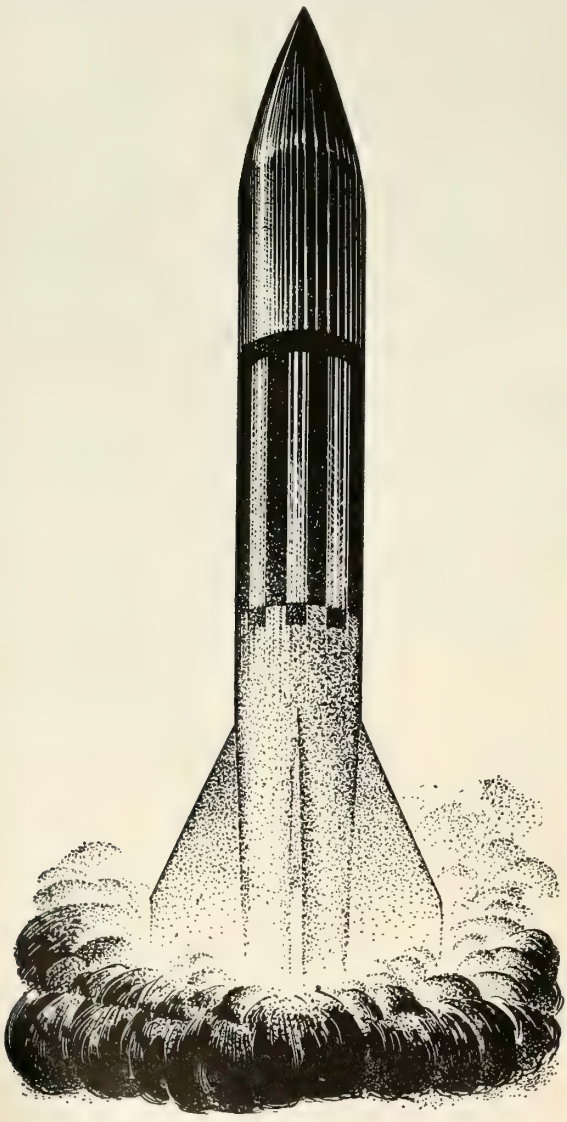
The proposed program incorporates many comments made by contractors and others through the American Ordnance Association, the Aircraft Industries Association and the Electronics Industries Association.

Members of the committee were: G. N. Beaton, Hughes Aircraft; K. J. Bossart, Convair-Astronautics; D. C. Cain, Navy Special Projects; R. F. Ohlemacher, Bendix Aviation; H. R. Powell, Ramo-Wooldridge; M. R. Seldon, Chance-Vought; O. E. Thomas, Boeing Airplane; and H. C. Wroton, Martin-Denver.

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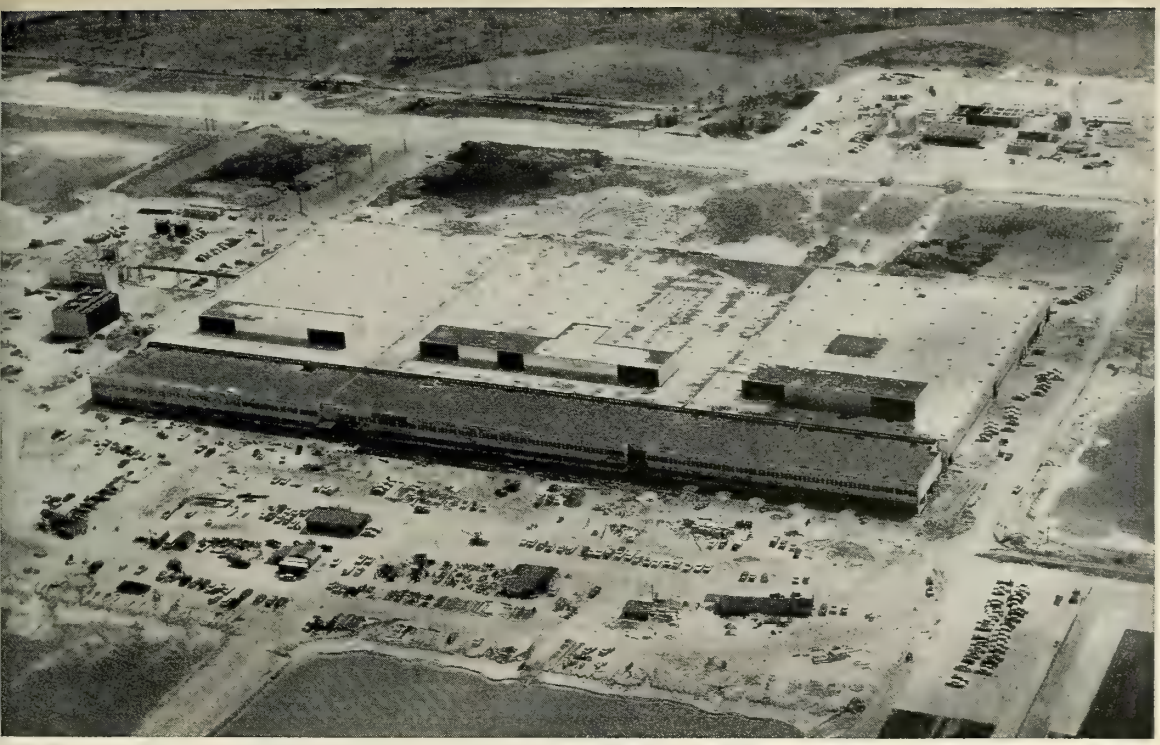
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THE MAIN PLANT of Pratt & Whitney's new Florida facility is slated for a big role in missile plans.

A Billion-Dollar Firm Shifts Into Space

by Erica Cromley

HARTFORD, CONN.—"Everybody's getting into the missile act." That was the reaction carried back from the Army's recent big missile shoot by Wright A. Parkins, vice president of engineering and manager of United Aircraft's newly unveiled Missiles and Space Systems division.

The new missile chief pointed to the diversity of the industries represented at the White Sands demonstration (m/r July 7, p. 36). "There were representatives of the tire people and the automobile industry. The radio people are deep into electronics; the oil people are in propellants."

Although the transition to missiles seems a more natural one for the air craft industry, United, last of U.S. aircraft's "big five" to get into the act, didn't initiate its missile division until June 24 of this year. Reason is that until recently, the billion-dollar corporation was up to its fuel lines trying to keep even with jet engine orders.

However, a heavy cutback in Air Force procurement last summer forced United's largest division, Pratt & Whitney Aircraft, (with 40,000 of the corporation's 60,000 personnel) to shear 5% of its employees. The board of directors, which had been "studying the situation" since 1956, decided in May to take the plunge and enter the competitive missile business in June.



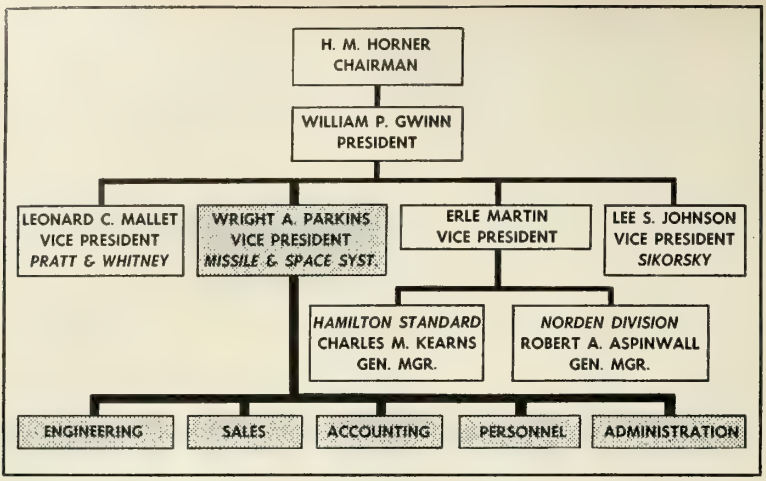
DYNAMIC MAN in a dynamic job, Wright Parkins was "the inevitable choice" to head United Aircraft's new Missiles and Space Systems division.

• **Norden is key**—United's earlier acquisition of the Norden-Ketay Corp., designer and builder of electronics systems, had rounded out the company's missile systems capability. Transfer of ownership was made July 1, on the basis of one share of United common stock for 20 shares each of Norden-Ketay's 1.3 million shares outstanding.

Norden Laboratories had been working on development and production of guidance and control equipment for such missiles as *Atlas, Titan, Redstone, Jupiter, Bomarc,* and *Regulus.*

Acquisition of the two new divisions spurred some reshuffling of UA's top brass. Vice President Erle Martin was moved up from general manager of the Hamilton Standard Division to director of both HS and the new Norden divisions. Charles M. Kearns, Jr., moved from assistant general manager to manager of HS; and Robert A. Aspinwall, assistant general manager of the Sikorsky Division, was made general manager of Norden.

Participation of United's four older divisions in UA's missile plans is expected to look like this: Pratt & Whitney — propulsion; Sikorsky — frames;



UNITED AIRCRAFT CORP.'s new organizational structure and departments. It will operate missile division from East Hartford, Conn., UA's main center of operations.

Hamilton Standard—fuel controls and accessory equipment; Missiles and Space Systems—overall management, development, and design.

Important roles will also be played by United's Research and Development and Advance Planning departments. To monitor advanced technical projects for both missiles and aircraft, the company added a new position to its top group: vice president and chief scientist. The post went to Perry W. Pratt, formerly engineering manager of Pratt & Whitney.

• **Test center available**—P&W's new Florida facility, which was opened in May of this year, can be used for outdoor testing of large rocket engines. Main work currently is on J58 Mach 3 jets.

Construction on the 7,000-acre site started in 1956 with an eye to future missile potential. The company invested a reported $30 million of its own capital funds into the non-severable equipment. This was matched dollar-for-dollar by the Navy Department for "severable" equipment such as machine tools.

Expansion of the facility to handle missile projects is now under way. New additions include labs, test stands and other test devices and rigs.

Parkins cites three plus-factors for the Everglade Swamp facility: (1) isolation (2) climate ideal for testing (3) location 17 miles northwest of Palm Beach, which has attracted an adequate number of skilled help.

• **Further expansion**—H. M. Horner, chairman of United, said the corporation will spend $50 million on additional plant facilities. Part of this will go to expand Pratt & Whitney's Willgoos Laboratory in East Hartford, Conn., which is "the most advanced and largest privately owned turbine test facility in the world."

• **Divisional setup**—Missiles & Space Systems has as yet no missile contracts. However UA's operating divisions, which cover each of the principle components in the missile system, are being groomed for their new tasks. M&SS will be purely a "white collar" operation and will farm out the work to operating divisions or to subcontractors. (Pratt & Whitney alone has over 9,000 subcontractors.)

Starting with a nucleus of 200 scientists and engineers transferred from Hamilton Standard, Parkins estimates that his division will swell to about 300 in a few weeks; will reach 500 by 1960; and will draw talent from other divisions as needed.

Hamilton Standard's electronics department, which terminated when its scientists moved into the new missile division, has been at work "in recent years on missiles." Proposals to manage small missile projects were made, but although some of these are still under consideration, none have yet been accepted.

There will be five main subdivisions of M&SS: engineering, sales, accounting, personnel and administration. Department heads for the first four will be transferred from other divisions. At present, the administrator is still to be hired.

• **Missileer in the making**—The man who heads United's missile unit joined Pratt & Whitney as development engineer in 1928, three years after it began operations in a garage with a total employment of six. The budding company's first design was the Wasp aircraft engine. That, and successive engines, helped the U.S. achieve a position of military world leadership within four years. P&W's engines powered 50% of all U.S. aircraft in World War II, and a substantial chunk of America's allies.

It was for this reason that United entered the jet field late. "When jets came along," Parkins said, "the military denied us entry into the field because they needed our piston engines. It wasn't until 1948 that UA stepped into the jet field with the J-57. Then jet engines took up so much of our effort and time, we couldn't get into the missile business that was coming up. We had the bulk of the jet engine business and that kept us plenty busy. Now jet engines are moving over to make way for the missile."

As the company grew, Parkins grew with it, moving up to Pratt & Whitney's engineering managership in 1944; assuming complete direction of both current and advanced engineering in 1949; and becoming a vice president in 1956, a post he still holds in addition to his new one.

Plus his high technical ability, Parkins has enormous physical energy, and a tenacity based on this philosophy: a machine is only as good as its reliability. Said one company official: "Parky was a natural for the job in light of his qualities and demonstrated ability to bring things through. He has played a vital role in bringing the airplane engine from 400 hp to production of the J-75 engine that delivers over 93,000 hp."

The company gives Parkins credit for the development of Pratt & Whitney's postwar piston engines, and points to his supervision of the several thousand engineers and technicians who developed present jets.

• **Optimist**—Understandably loathe to project M&SS' future into estimates, Parkins will only say that he is optimistic, and that the company is in the missile business to make money. "We've done some jobs for the government where we couldn't get a return, and we possibly would again, but we're going into this missile program on our own. There was no request from the government. We're going in to further our future. We can do all this with practically no help from the government for additional facilities."

Two years ago United's missile chief made a statement on United's progress which he may well be pondering now as he faces the new challenge: "We've come a long way from the horse. But if we're to get wherever it is we're going, we've got a confounded long way to go."

Russian Development May Aid WS-117 Program

With some 50 subcontractors involved and millions programmed in the next several years, Lockheed Aircraft Corporation's Missile Systems Division is pushing for test firings this fall using *Thor-Able's* for the WS-117L reconnaissance satellite program.

And ironically, it appears that a Russian development, accidentally stumbled on from translation of technical documents, may provide the light-weight nuclear power source needed to operate the satellite's reconnaissance equipment in advanced models. Many researchers feel the revolutionary discovery may provide a very close approximation of direct conversion of atomic energy into electrical energy, thus paving the way for the so-called "exotic" electrical propulsion systems.

WS-117L now consists of three programs under the code name of SNAP (Secondary Nuclear Auxiliary Power). Originally, the WS-117L program started out as Big Brother, but had its name changed to Pied Piper because of name conflict with an organization devoted to the aid of underprivileged youth. Succeeding reports called it the Sentry satellite, but SNAP now appears to be the settled code name.

Defense Department and Lockheed, under strict orders from the White House and Department of State, are not permitted to discuss WS-117L because of its international "Peeping Tom" implications.

It is known, however, that an *Atlas* booster with a second stage solid—presumably the same as used on Lockheed's *Polaris*—ultimately will orbit one to 1½ tons, although initially most of the weight will be batteries. More useful payloads will have to await development of auxiliary nuclear power sources. This part of the program involves:

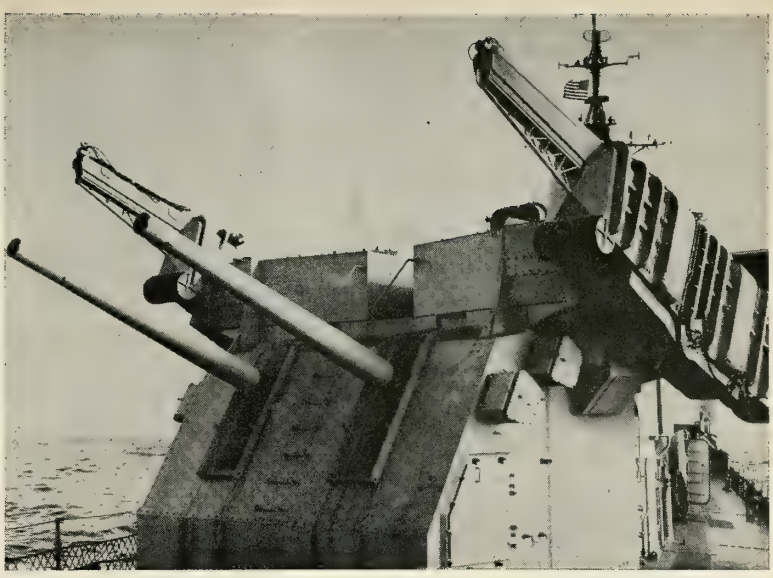
SNAP I—Here, radioactive isotopes, rather than a nuclear reactor, would be used as a heat source. Martin Company has a prime contract in excess of $1 million to investigate the use of Cerium 144. Cerium reportedly is cheaper and poses less radiological hazards. Thompson Products has a subcontract for some machinery in this program phase.

SNAP II—This involves installation of a thermal reactor in the satellite. Atomics International, which has invested some $885,000 in facilities and research, has the prime contract. Cosmodyne Corp., Los Angeles, reportedly is doing some research work. Thompson Products also is assisting in this phase.

SNAP III—This is the program where the Russian development is being used, which could lead to the close approximation of direct conversion of atomic energy into electrical energy. The device, it was learned, initially would give out three watts of electrical energy for 6 months and probably would not weigh 10 pounds. Early uses could be for a *Vanguard* satellite.

The gadget reportedly is about 8% efficient, and possibly could go to a 25% efficiency. Westinghouse, in cooperation with Navy, is doing research, and it is felt that materials used would not be damaged by radiation.

The Defense Department has assigned top priority to its reconnaissance satellite program. The rate of expenditure on the WS-117L program will triple in fiscal year 1959, over 1958. ARPA has $152,000 million programed for 1959, compared to $55 million spent in 1958. The satellites will be launched in Polar orbits from Cooke Air Force Base, Calif.



THE ROCKET-ASSIST TORPEDO *(Rat)* **launching system utilizes the after five-inch gun mount and fire control system of destroyer to provide an anti-submarine weapon of greatly improved accuracy and extended range of about five miles. Solid propellant first stage by Allegheny Ballistics boosts torpedo into flight and propels it along ballistic flight path to general vicinity of submarine. Nose cone and parachute separate as *Rat* enters water to acoustically home on target.**

Republic Launches $35 Million R&D Effort

Republic Aviation Corp. has begun a $35 million research and development program, designed to capture a position of leadership for the firm in the field of astronautics.

The four-year program includes erection of a $14 million engineering Research and Development Center at the firm's Farmingdale, L.I. facility. A major expansion of the company's technical personnel is also contemplated.

The program has the overall aim of developing new, more sophisticated forms of missiles and aircraft; and simulating manned vehicles for space travel.

Nose Cone Recovery Balked by Lack of Gas

CAPE CANAVERAL, FLA.—The attempt to recover the mouse-carrying nose cone of the latest *Thor-Able* test flight was once again beset with failure and frustration through a series of accidents.

According to reliable sources two Air Force search planes sighted the nose cone as it reentered the atmosphere and a short time later located it floating in the ocean. One plane circled the cone for three hours radioing the ships assigned to the recovery program. Sailing at full speed, the ships were nearing the area when the plane's fuel supply became so low that it had to leave and return to base.

The ships searched the position radioed by the plane for several hours without success. The search was finally abandoned even though Wickie, the mouse, was expected to live for several days.

This was the third *Thor-Able* firing in recent weeks. Another *Able* type vehicle is being readied in its gantry for what could well be the first Air Force lunar probe attempt sometime this month.

missile people in the news

Industry



R. W. Cook, former deputy general manager of the Atomic Energy Commission, has joined American Machine & Foundry Co. as director of administration, Government Products Group. Cook resigned his AEC post in June. He had been associated with the nation's atomic energy program since 1944, and with the Commission since 1947.

J. R. Moore has been appointed senior program administrator for Rocketdyne programs sponsored by the Navy, Wright Air Development Center, Office of Scientific Research. **W. E. Buchanan** continues as senior program administrator for programs sponsored by the Ballistic Missile Office, and **B. F. Deming** will continue in the same function for programs sponsored by the Army Ordnance Missile Command.



Adm. Selden B. Spangler, USN (Ret.) is the new director of research for the Garrett Corp., Los Angeles. Spangler, whose appointment is effective August 1, recently retired from the Navy after 39 years of service. His achievements include the directorship of the Power Plant Division of the Navy's Bureau of Aeronautics during World War II.

Fred W. Schwier has been appointed general sales manager of Aeroquip's Jackson Division. Schwier was recently assistant aircraft sales manager, and has been associated with Aeroquip Corp. in a sales capacity since joining the company in 1951.

Instrumentation



J. R. Dempsey, manager of Convair - Astronautics, was appointed vice president of Convair Division of General Dynamics Corp. He is the Convair executive directly responsible for delivering an operational *Atlas* intercontinental ballistic missile to the Air Force's Strategic Air Command.

L. Rene Gaiennie has been elected vice president of industrial and public relations of ACF Industries, Inc. Gaiennie's duties will encompass labor relations, public relations, personnel, wage and salary administration.

Company Officers

Joseph Meisler has been appointed technical commercial manager of the Cryogenics Department, Philips Electronics, Inc. He will have charge of low-temperature problems and applications involving the Norelco liquid air and liquid nitrogen generators.

Robert R. Miller and **Thomas V. Jones** have been elected to offices as senior vice presidents with Northrop Aircraft, Inc. Northrop also elected **Richard R. Nolan** and **Irving Roth** as corporate vice presidents, and assigned Nolan responsibility as general manager of the Northrop Division.

Charles W. Sinclair has been appointed vice-president-engineering for divisions of the Kelsey-Hayes Co. Sinclair, who has been with Kelsey-Hayes since 1911, was chief engineer for the automotive division.



Charles H. Rodgers was elected vice president of Consolidated Diesel Electric Corp. with primary responsibility for financial operations. He was previously associated with Servomechanisms, Inc., where he was secretary-treasurer for eight years.

Louis A. deRosa, Sven H. Dodington, Armig G. Kandoian, Arnold M. Levine, Dr. Charles D. W. Thornton have been elected vice presidents of the consolidated IT&T Laboratories. The newly-formed organization combines the research facilities of Farnsworth Electronics Co. and Kellogg Switchboard and Supply Co., both IT&T divisions, with Federal Telecommunication Laboratories, the former research division of IT&T. The officers and their fields of responsibility are: deRosa, electronic countermeasures; Dodington, avionics; Kandoian, communication systems; Levine, missile systems; Thornton, physical sciences.

Paul Dulong has been appointed manager of the Engineering Services department, Epsco, Inc. He will supervise all drafting, mechanical design, mechanical engineering, standards, technician training and testing facilities.

John A. Grimes has joined Consolidated Diesel Electric Corp. as general manager, Test Equipment Division. Grimes has been with the company for three years as administrative engineer and assistant to the president.

Advertising correspondence should be addressed to Advertising Sales Manager, Missiles and Rockets, 17 East 48th Street, New York 17, N.Y.

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advertiser's index

Aerojet-General Corp., Sub.—The General Tire & Rubber Co. 8

Armco Steel Corp. 30

Avco Mfg. Corp. .....Cover 3

Diversey Engineering Co. 4

Dow Chemical Co., The 3

Food Machinery & Chemical Corp. 25

Hydro-Aire, Inc. .....Cover 2

Janitrol Aircraft, Automotive Div., Surface Combustion Corp. 7

Lithium Corp. of America, Inc. 6

North American Aviation, Inc. 26

Space Technology Laboratories, Div.—Ramo-Wooldridge Corp., The 23

Thiokol Chemical Corp. ..Cover 4

Thompson Products, Inc. 17, 18, 19

Titanium Metals Corp. of America 10



Avco's honeycomb "sandwich" takes pounds off

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AUGUST 11, 1958



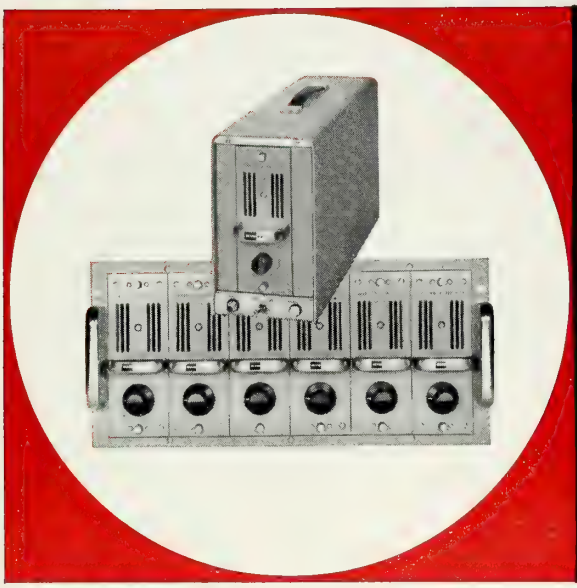
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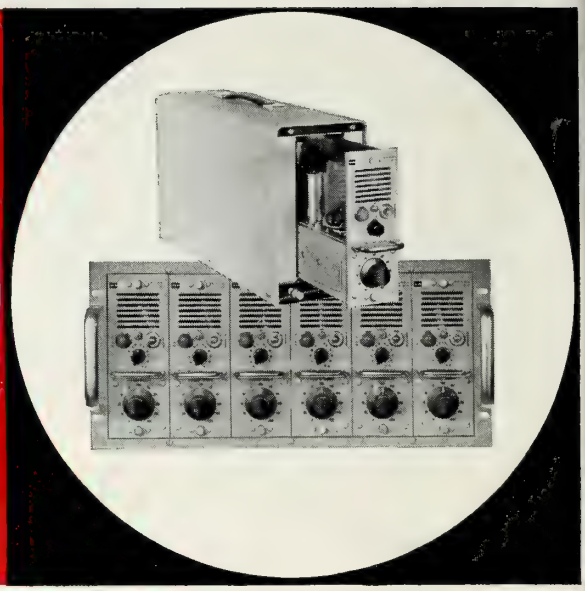
MAGAZINE OF WORLD ASTRONAUTICS

Engineering and Electronics Edition

AN AMERICAN AVIATION PUBLICATION

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AUGUST 11, 1958
VOL. 4, NO. 6

missiles and rockets
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news

$6.6 Billion For Missiles This Year
by Seabrook Hull 12

Air Force Re-establishes Space Office 14

U.S. Not Racing Anyone To Space 16

Firing Date Dubious For Lunar Probe
by Donald E. Perry 17

features

m/r special report:

Solid Fuels Vie For Propellant Lead
by Alfred J. Zaehringer 28

Recorder Offers Speedy Data Processing
by Richard Van Osten 38

Shock Tests Vital as Birds Get Bigger
by Raymond M. Nolan 40

Astrodyne Shifts to Cast Grains 45

Why Not A Logical Approach to Space Flight?
by W. O. Davis 49

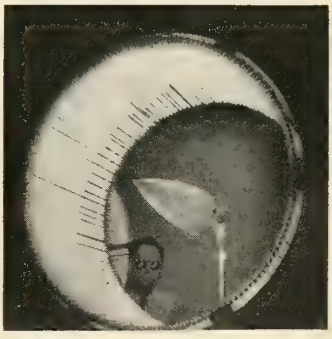
Soviets Discuss Satellite Crew Recovery
by Frank G. McGuire 51

columns

World Astronautics 55
Keeping Track 59
Space Age 74
Missile Business 79

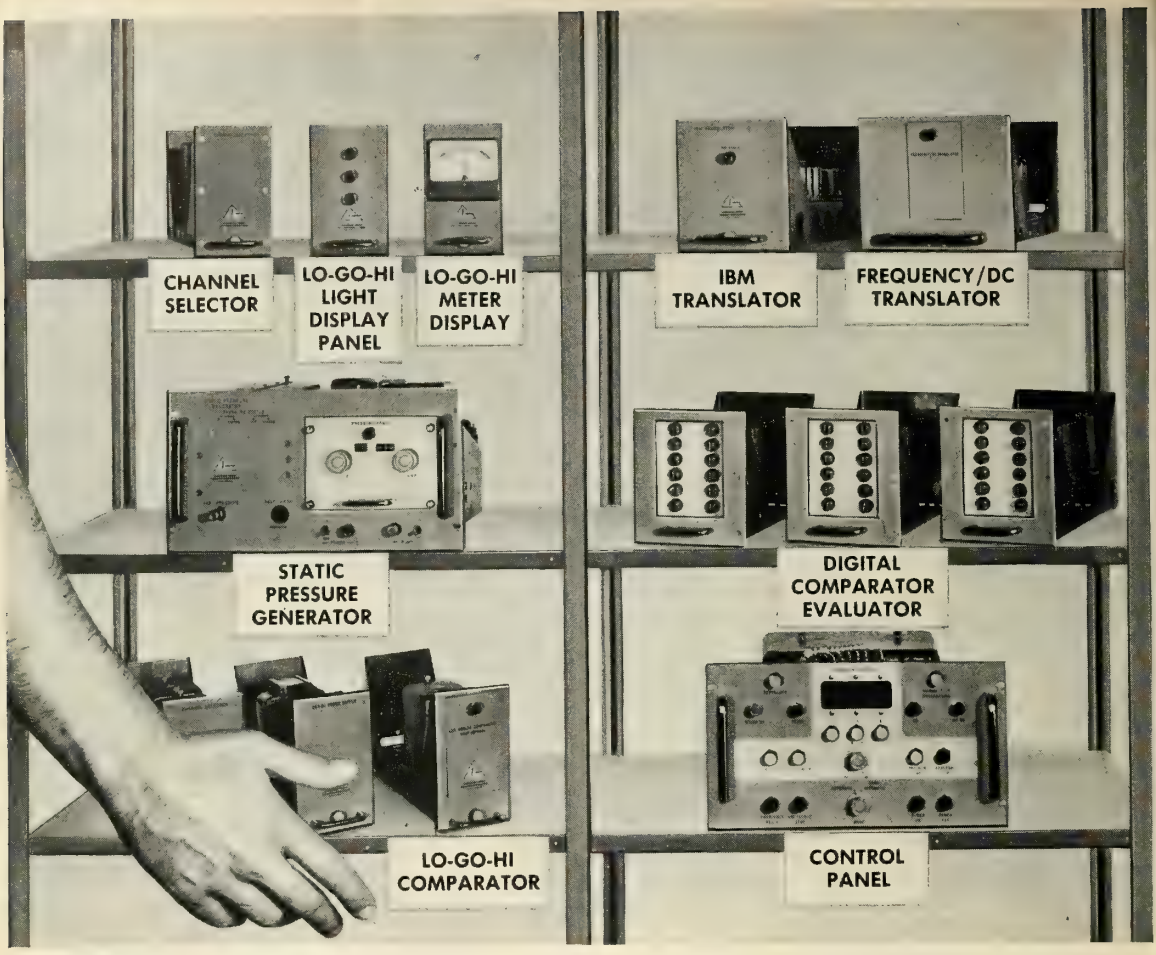
departments

Editorial 7
Industry Countdown 9
Washington Countdown 11
Book Reviews 56
When and Where 57
Missile Electronics News 60
New Missile Products 66
Letters 73
Contract Awards 79



cover

A scientist standing behind a glass panel and wearing protective goggles observes the test of a missile nose cone exposed to simulated aerodynamic heating conditions in a cylindrical radiator which incorporates 225 quartz-tube heat lamps. The tests are conducted at the Langley Aeronautical Laboratory of the National Advisory Committee for Aeronautics.



A few of the modules now available

Now...modular components for automatic weapons testing systems come

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We're The Best In The World!

Big deal! We have an operational ICBM! This is what the daily newspapers have been reporting in the last few days—ever since the successful firing of an *Atlas* that went some 2,300 miles (see page 17).

We read such press statements quoting unnamed "officials" as saying "now we can start turning them out like refrigerators" or "jubilant missile men were convinced today the United States has matched Russia in possessing an intercontinental ballistic missile."

In a United Press International dispatch from Cape Canaveral we caught the following: "spirits soared over the weekend in the wake of the first successful firing of a fully-powered ICBM. It assured engineers, technicians and other missile men that this country now could match Russia's asserted capability of hitting targets on another continent with hydrogen warheads."

Other sources described the successful *Atlas* firing as a "major break-through in the missile race with Russia."

Says who? Pure bunk. We object to having the American public misled into believing that the U.S. is far advanced in ICBMs when that just isn't so. A single successful firing of the *Atlas* is only an early step forward. The press agents—and USAF must be included among the guilty—have been working overtime to balloon our accomplishments above reality. The net result is to lull the public into a false sense of security. The most elementary technological advance simply doesn't comprise a "major break-through."

It appears we are getting right back to the complacent status we began to get out of on October 4, 1957. We were disappointed to read recently that even Hugh L. Dryden, who is slated to play a major role in our multi-million dollar "civilian" space agency, has publicly indicated the U.S. is not trying to catch up with the Russians because we are not in a race with them. (Hearing before the Select Committee on Astronautics, Second Session, H.R. 13619. See page 16).

Of this we are certain: if the U.S. doesn't stop being complacent, if it doesn't realize it is in a race whether it likes it or not, this nation is in dire trouble. The facts, very ably analyzed recently by columnist Joseph Alsop, are that this country is way, way behind in the ICBM race and that the Russians will be ahead of us for many, many years. Furthermore, is it just a matter of catching up with the Russians? Or should we aim at leadership and move ahead of the Russians?

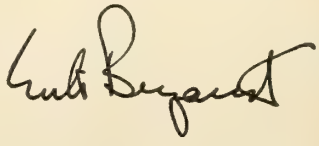
One thing is certain—deluding the public by false impressions created by the *Atlas* shoot will accomplish nothing. Our missiles are designed as offensive weapons for immediate retaliation. They must be launched—dozens at a time—instantaneously, from numerous secret bases. Countdown must be accomplished in seconds, not hours or days. We are a long way from that stage of progress.

Let's face the truth and the facts. This country is far behind in the missile field. For too many years, the Pentagon ignored the missile threat. Even many in the aircraft industry were skeptical and proposed no programs. A few firms like Convair, North American, Douglas, and Boeing struggled along with meager funds. The U.S. lacked a major push. Russia's *Sputnik* produced a spark of urgency last October, but what has happened to the major drive that began getting underway at that time?

The U.S. is still in need of topside leadership. We have the brainpower to overtake the Russians, but it isn't yet being used. There is still no real spark of urgency or leadership in USAF when it comes to a forward missile program, and we are disappointed that the aircraft industry hasn't stepped to the front as many had hoped it would.

The challenge of space flight remains. The Pentagon is most unlikely to accept it. But the aircraft industry can do so. If industry can convince Washington of the real facts of life, and help plan for the future of space, we will avoid running second to the Russians in the future.

Single missile shoots are fine. But these are a long, long way from missile power in being.





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INDUSTRY COUNTDOWN

HOW'S BUSINESS?

Thiokol's net sales for the first six months of 1958 totalled $32.3 million, compared to $25.7 million for same 1957 period. But net income totalled $865,756 for '58, compared to $838,493. Figures for period compared include Reaction Motors, acquired by Thiokol as of May, '58 . . . **Consolidated Electrodynamics** reports sales of $15.4 million for first half of '58, compared to $15.2 for '57 period . . . **Temco Aircraft,** in same budget period, shows a record high sales, $61.5 million, with net earnings up 9 cents a share from '57 . . . **Clevite Corp. had sales** of $31.9 million for first half of '58, down from the '57 period, when sales were $39.7 million. Earnings dropped from $1.48 a share in '57 to $.74 a share this year . . . **Monarch Machine Tool Co.** showed net earnings after taxes of $142,717 for first half of '58, compared to $678,485 in same '57 period . . . **Ryan Aeronautical Co.** declared its regular quarterly dividend of 10 cents a share . . . **Genisco, Inc.,** declared a 7½ cent dividend . . . **Directors of Victoreen Instrument Co.** authorized redemption on Aug. 20 of $100,000 of the company's $700,000 outstanding 6% convertible subordinated debentures . . . **Shaffer Tool Works,** Brea, Calif., after 35 years of manufacturing oil field equipment, announced it was entering the field of general industrial valves—some of which might be applicable to missiles.

MERGERS AND NEW VENTURES

Airtron, Inc., completed exchanging 100% of its stock for an undisclosed amount of stock of Litton Industries, Inc. Airtron, leading producer of ferrite devices, waveguides and related components, will take over Litton's Components Division in Los Angeles, Airtron President David Ingalls becomes a Litton vice-president . . . **Sequoia Wire and Cable Co.** has acquired Hall-Scott Electronics, of Burbank, Calif., for special emphasis on work for missile and aircraft industries . . . **Pyle-National Co.,** Chicago, manufacturer of electrical connectors, fittings and lighting equipment, takes over Steber Manufacturing Co., Broadview, Ill. . . . **Cushman Precision Industries,** a new firm, has been established at Princeton Junction, N.J., to specialize in development, test and manufacture of electro-mechanical precision rotating components for electronics and missile applications . . . **Lerma Engineering Corp.** has established headquarters at Northampton, Mass., for design and manufacture of optical equipment . . . **Cosmodyne Corp.** has been formed at Los Angeles, for advanced research and development in auxiliary power and environmental control systems.

EXPANSIONS

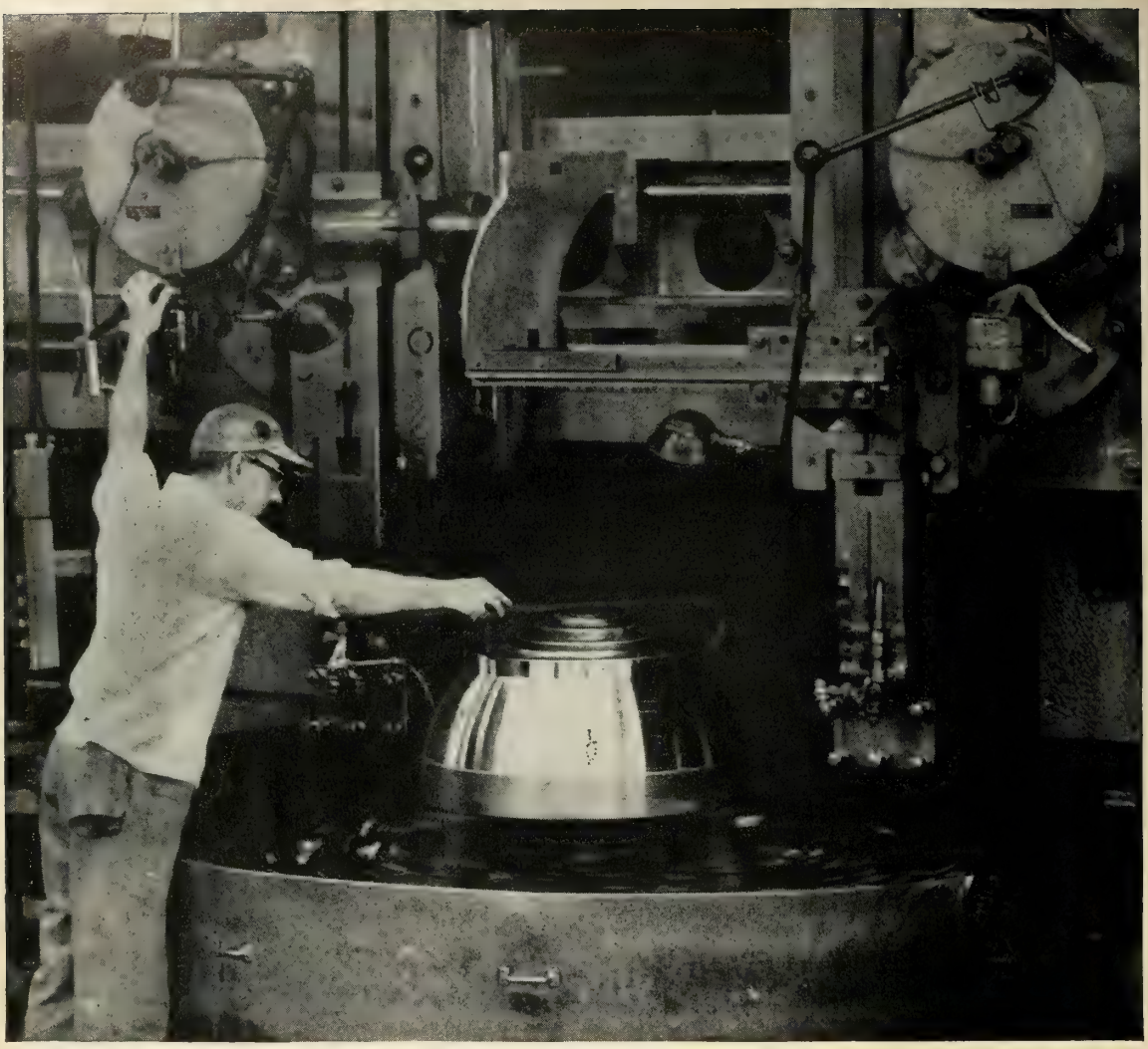
Stauffer Chemical Co. will build a $300,000 unit at Richmond, Calif., to supply tantalum and columbium pentachlorides . . . **A new laboratory** for development of new silicone products is now being occupied by Silicone Products Department of General Electric Corp., at Waterford, N.Y. . . . **Aerojet-General Nucleonics** has completed design of a 24,000 sq.ft. engineering office and an 18,000 sq.ft. laboratory and shop at San Ramon, Calif. for nuclear reactor production . . . **Ramo-Wooldridge** announces plans for transferring its advanced electronic research operations to a 90-acre site in the Canoga-Park-Chatsworth area in Los Angeles. Plans will be final if the city Planning Department grants permission for the multi-million unit. It'll house some 2,000 scientists, engineers and administrators initially . . . **Tempo Instruments Inc.,** has moved its entire operation to a 10,000 sq.ft. plant at Hicksville, N.Y.

LATE CONTRACTS

Douglas Aircraft Inc., Santa Monica, gets a $24 million contract from Army for *Nike-Hercules* program . . . **Chrysler Corp.,** Detroit, got $16 million Army contract for work on *Jupiter* . . . **Philco Corp.** has $2.5 million Army contract for radar reconnaissance system . . . **Beckman Instruments, Inc.,** has received a $150,000 contract from Sundstrand Turbo, for an electronic system to determine efficiency of accessory power supplies for guided missiles prior to launching . . . **Packard-Bell Electronics Corp.** has a $300,000 contract from Aerojet-General to develop a missile impact prediction system for Cooke Air Force Base . . . **U.S. Borax Research Corp.**—a wholly-owned subsidiary of U.S. Borax & Chemical Corp.—got a contract from Air Force to study high-temperature inorganic polymers, and chemistry of new solid rocket propellants . . . **New contracts** totalling $1.8 million have been received by Telecomputing Corp., Los Angeles, for production of gyros used in *Nike-Hercules.*

MISCELLANY

Convair Division of General Dynamics Corp. says its nuclear laboratories at Fort Worth is working on a series of controlled fission product tests, as part of a joint Air Force-AEC nuclear propulsion safety program . . . **More than 12,000 workers** at Northrop and Nortronics Division of Northrop Aircraft got a 1-cent an hour cost-of-living pay increases August 4.



Contour machining of an aft dome for a U.S. Army missile.

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WASHINGTON COUNTDOWN

• **AIRCRAFT-LAUNCHED SATELLITE?**—As m/r went to press—Navy was reported ready to try the first real probe of space—aircraft launch. Best information was that the probe —a 2,500 lb vehicle with a three-pound payload—will be hung on an F8U and launched at an altitude of 80,000 ft over Inyokern, Calif., possibly this week. Named *Pilot,* vehicle may include up to five stages, and seems to be far more economical than launching from a balloon, as in Project *Farside.*

• **FINANCES CUTTING SECRECY**—A sidelight on the continuing pressure on the Pentagon for economy could well be "less secrecy." Reason: paperwork on a classified project is considerable; and construction of big fences and king-sized "chemises" to cover missiles and aircraft from public view is very costly. Air Force, in particular, is pushing hard at downgrading classified information on as many projects as possible, as soon as possible.

• **WARHEADS LACKING**—There are grave implications in Atomic Energy Commission's report to Congress that, though nuclear weapons are being expanded rapidly in numbers and kind, there is still a lack of nuclear warheads for long-range missiles and anti-missile-missiles. AEC says it hopes to remedy this situation partially through current tests in the Pacific, but presumably the bulk of weapons in U.S. stockpiles are bombs of various sizes. Problem is that warheads must wait on development of missiles.

• **NUCLEAR DEVELOPMENTS**—In the same report, AEC had some interesting things to say about nuclear-powered rockets: results of research on nuclear power for long range missiles and space craft are "encouraging." First round of tests on a research rocket reactor, said the agency, will be conducted in Nevada late in 1958. Another point: There has been "significant progress" made on nuclear ramjet engines that could drive missiles of "unlimited range." And a third project, to provide nuclear auxiliary power for space vehicles (*Rover, Pluto* and *Snap*), looks "promising."

• **AUTHORITY UP—MANPOWER, MONEY DOWN**—Many Defense Department officials, who have happily looked forward to Reorganization as a source of increased authority and scope, are having some misgivings, now that the bill has been ok'd by both houses of Congress. It begins to appear that authority and workload will certainly increase—but manpower and money won't be increased so readily.

• **BATTLING RENEGOTIATION**—Major missile/aviation manufacturers continue pounding away at the renegotiation act. Latest to appear in favor of amendments was James H. (Dutch) Kindelberger of North American Aviation. Kindelberger stated that the bill introduced by Congressman C. R. King of California, providing for appeals to the courts from decisions of the tax court in renegotiation matters, should be supported. "Otherwise," he commented, "the tax court becomes a trial court and appellate court as well." And, he added, the tax court is so swamped that it has petitions from major aircraft companies that it hasn't been able to act on in two years.

• **MORE ON SECRECY**—There's a great deal of importance to missile-men in that bill the Senate passed last week (and sent to the House) aimed at preventing federal officials from "arbitrarily withholding" information under a 1789 statute. That old statute authorized department heads to make regulations for the "custody and use" and preservation of records. The new bill adds this significant sentence: "This section does not authorize withholding of information from the public, or limiting the availability of records to the public."

$6.596 Billion For Missiles This Year

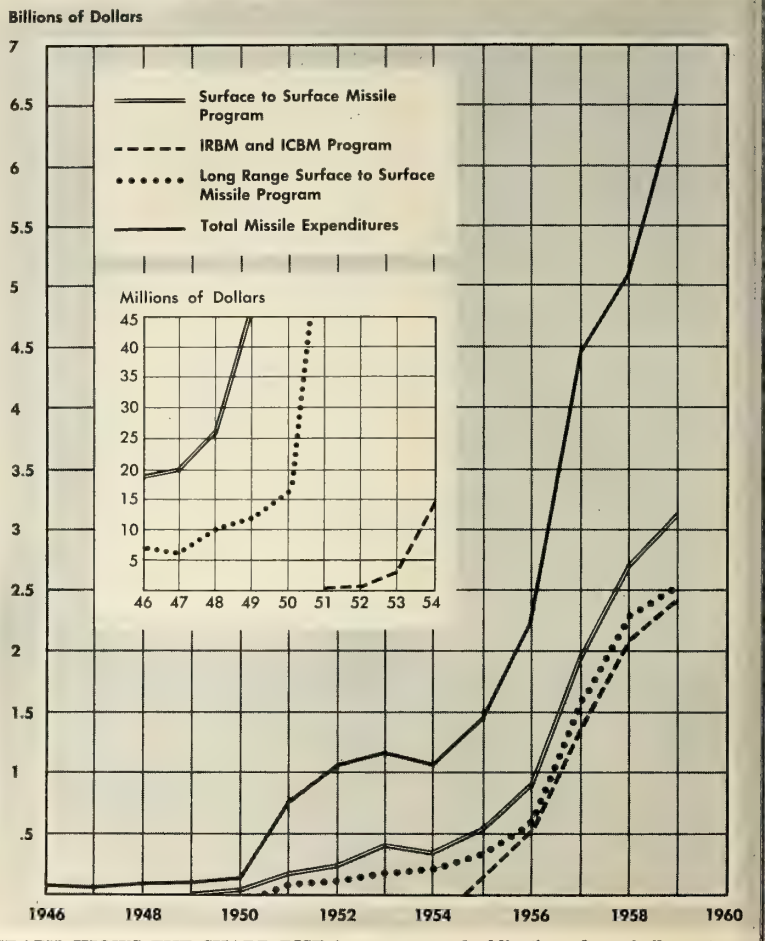
by Seabrook Hull

Missiles and space flight become a $6.596 billion business in fiscal year 1959—the 12-month period starting July 1, 1958 and ending June 30, 1959.

Recently compiled figures of the Department of Defense show that programmed obligations (roughly speaking, what's available to Army, Navy, Air Force and the Defense Department to be placed in the form of contracts) for 1959 for all missile procurement, construction and research and development, comes to $6.596 billion, compared to $5.107 billion in Fiscal Year 1958.

This is the first time that the Department of Defense has really had any concrete idea of the impact of the missiles and astronautics business on the national economy. Graphs and charts accompanying this article demonstrate the growth. There is no indication that this growth will level off anytime soon. In fact, the prospect of upcoming space flight spending requirements staggers Washington's budget-minded planners.

No firm figures have been developed to show the actual comparable level of expenditures—cash and checks paid out for work performed—for the missile business as a whole. However, experience shows that expenditures normally follow obligations by between 10 and 18 months. If this holds true—and it probably will—it means that Uncle Sam will actually pay out a little over $5 billion in Fiscal '59 for missile-based weapons systems and space flight projects. In fiscal 1960, expenditures will top $6 billion.



GRAPH SHOWS THE SHARP RISE in programmed obligations for missile systems. The box is merely an enlargement of the earlier years.

• **How much for R&D?**—Other figures developed by the Defense Department emphasize the state of the art. Contracts to be placed by Army, Navy and Air Force for missile research and development activities alone this year come to $610.7 million, not including Advanced Research Project Agency's $520 million, which would bring the total to $1,130 billion.

However, add in test and evaluation programs like the firings at Cape Canaveral, cold-weather tests at Fort Churchill in Northern Canada, and the total being spent to develop and then to prove weapons systems based on missiles comes to $1.923 billion—not including ARPA.

• **Figures add up**—The difference between this research, development, test and evaluation total and the full $6.596 billion in programmed obligations for all missile-related work lies in orders for production missiles, construction of missile bases, and orders for directly concerned support equipment.

For example, this takes into account costs of converting Navy ships to missile-launchers but not the basic cost of the ships themselves.

Exceptions are the submarines required for launching *Polaris* missiles. Since these submarines will have only one basic use, and since they are essential to the success of the *Polaris* concept, the full charge of the *Polaris*-launching submarines is included.

This program, incidentally, is a good example of how expensive missilery is getting. The total worth of the *Polaris* program so far is $1.25 billion, including research and development contracts on the bird itself and funds for the first five submarines. This figure does not include funds for the extra four subs that Defense didn't ask for, but Congress authorized.

On the extra money being voted by Congress, Defense Secretary McElroy had this to say: It will give the Defense Department greater flexibility in its operations. McElroy didn't say he wasn't going to spend it, but he won't spend it unless he thinks it's worthwhile.

For example, the Secretary sees no point in laying the keels for the four extra *Polaris* submarines until there is greater assurance that the *Polaris* concept isn't going to encounter any unanticipated snags. The Navy will be allowed to order some $15 million worth of long lead-time components per submarine right away. But if *Polaris* runs into long delays, these components can be used on any nuclear-powered submarine.

The same philosophy is being ap-

plied to *Minuteman*, over which McElroy thinks Air Force publicity is "prematurely enthusiastic." For *Minuteman* to be a practical weapon, either guidance or propulsion, or both, need material improvement before the full bird can be ordered into final R&D as weapons system.

• **Includes all procurement**—The $6.596 billion of programmed obligations for missile systems in the current fiscal year includes all procurement, construction and research and development funds directly associated with missile programs.

Military Research & Development Appropriations
($ in Million)

FY	missiles	total
1955	214.0	1,349.6
1956	280.4	1,539.0
1957	355.8	1,651.4
1958	424.0	1,720.1
1959	1,130.7	2,493.1

These figures do not include military pay, operation and maintenance costs for operational missile units and sites, and include only those shipbuilding and aircraft costs directly associated with providing missile capability.

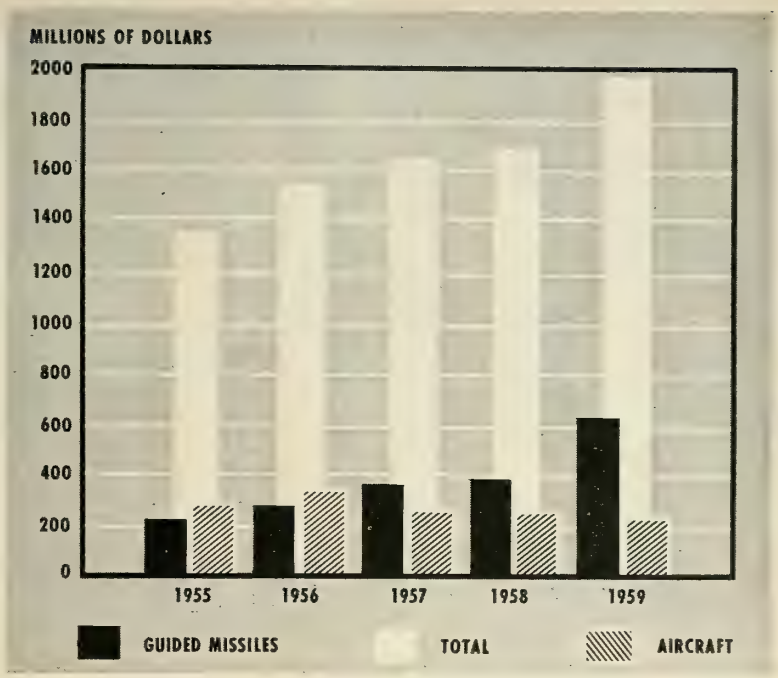
Of this total, $2.430 billion are earmarked for IRBM and ICBM systems; $95 million for other long-range surface to surface missiles *(Regulus, Matador)*; $593 million for the shorter range surface-to-surface missiles like *Little John, Honest John, Redstone, Lacrosse*; $3.478 billion for all other missiles such as surface-to-air (*Bomarc, Nike* series, *Talos*), air-to-surface (*Bullpup, Rascal*), underwater-to-surface (*Subroc* but not *Polaris*).

These figures also show that by the end of fiscal '59, contracts total $6.568 billion that have been placed for big ballistic missiles since 1946, including the Air Force MX-774 (pre-*Atlas* study), *Atlas, Titan, Thor, Jupiter* and *Polaris*.

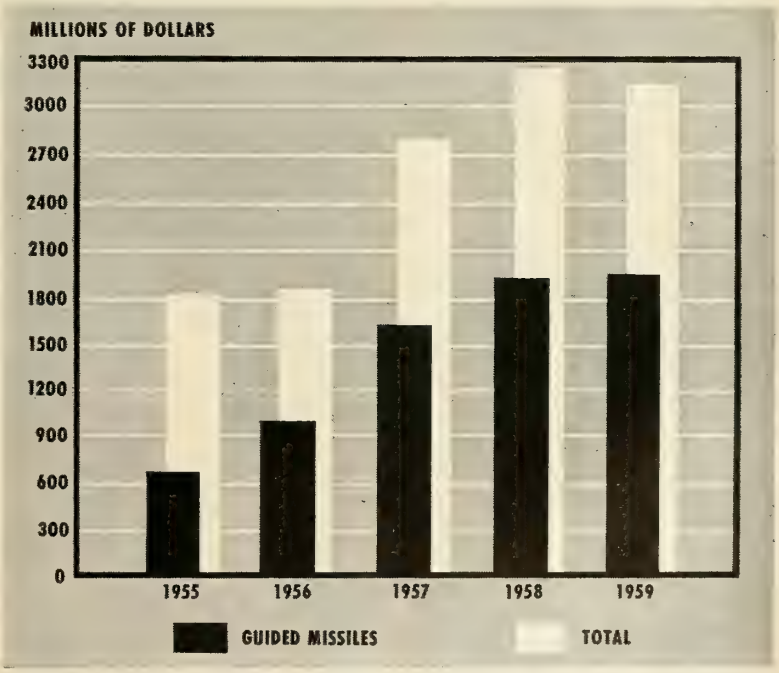
The grand total of U.S. contracts placed for missile systems research, development, construction and production for the 14 years from 1946 through 1959 comes to an impressive $24.429 billion. Prospects are that this much will be spent again in the coming years of 1960 through 1962, including, of course, expenditures for space flight projects.

The Pentagon's next big statistical job in relation to missiles will be to attempt to find out, industry-by-industry and commodity-by-commodity where this money goes. This task will be made immensely easier once the Missile Manufacturers Planning Reports (m/r, July 25, p. 12) have been sent out and returns begin coming back from the companies that make missiles. At the moment, the Pentagon has no idea of the detailed impact this massive spending is having on the national economy. Similarly, there is no way of knowing right now, just how far or how fast missile system production could be expanded in an emergency.

The odds are, however, that both this information and a breakdown of where the money is going will be available within 12 months.



BAR CHART COMPARES the programmed obligations for research and development, comparing aircraft (dropping), missiles (rising), to the total.



HERE IS A COMPARISON of programmed obligations for research, development, test and evaluation between missiles and the total for all weapons systems.

AF Re-establishes Space Office

With the full cooperation and approval of the Advanced Research Projects Agency and the Department of Defense, the Air Force this week re-established, in name, a space technology office under Brig. Gen. Homer A. Boushey.

Formerly known as the "Director of Astronautics," Gen. Boushey now—as "Director of Advanced Technology" in the office of the Deputy Chief of Staff/Development—will head the key air staff activity concerned with advanced technology and all AF matters pertaining to space. The office will work closely with ARPA, the Departments of the Army and the Navy, and the newly designated NASA.

Shortly after setting up Gen. Boushey's office last December, as the office of the "Director of Astronautics," DOD ordered suspension of the title because it was considered "contrary to assurances given the Secretary of Defense that no such action would be taken until it could be coordinated with the specific plans for the new agency in the Department of Defense."

"This office," Gen. Boushey said, "will supervise at Air Staff level the formulation of an AF advanced technology program, including space technology."

Additional responsibilities include maintaining liaison with educational institutions, industry and representatives of foreign governments engaged in research and development activities.

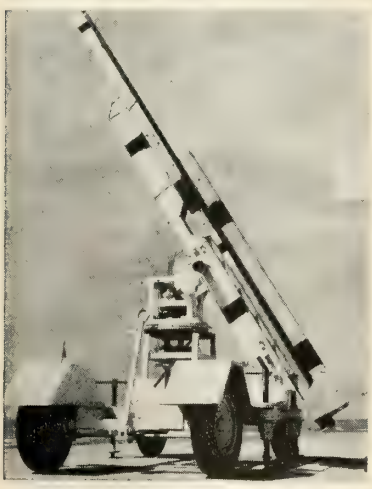
The office will have cognizance of all Air Force study projects, such as earth orbiting, orbiting the moon, development of space navigation systems, methods of transfering material and personnel from one vehicle to another while in orbit, and related matters.

It is understood that the Air Force, in cooperation with other agencies, is planning other projects, including possible space probes to Mars and planets, which might follow successful moon probes. However, indications are that such projects are still in the pencil-and-paper-stage, and cannot be anticipated in the immediate future.

• **Dyna-Soar too**—Among the projects which will come directly under the Air Force and Gen. Boushey is the Dyna-Soar system. The General pointed out that this, in actuality, is not a space program but a boost-glide system. He admitted that it was possible that Dyna-Soar could later be adapted to space flight.

Contracts were recently awarded to Martin-Bell and to Boeing Airplane Company, and may continue for as long as 12 to 18 months. However, Gen. Boushey said that as soon as one company or the other proves to be more capable, a contract would be awarded. The study competitions costs are being taken over by the Air Force, but both companies are putting substantial funds of their own into the studies.

Gen. Boushey, who made the first U.S. flight powered by rocket propulsion, told Congress last spring that the moon could be used as a base to fire rockets accurately at the earth.





PHOTOGRAPHS AND DATA on the latest Japanese sounding rockets indicate a remarkable advancement in the state of the art. Both of the rockets shown were developed by Professor Hideo Itokawa, Institute of Industrial Science, University of Tokyo. Itokawa is head of Japanese IGY sounding rocket program. K-150 rocket (left). Single-stage, solid propellant sounding vehicle fired April 8, 1958. Diameter—150mm. (5⅞ in.); length—3.3m (10¾ ft); weight—70kg (154 lbs). *Kappa* Type V two-stage rocket (right) fired April 29, 1958. First stage diameter—220mm (8⅝ in.). Second stage—K-150 rocket. Maximum velocity—about 1,000 m/sec (3300 ft/sec).

SRI Obtains New Data On Liquid Fuels

New data on the specific conditions needed to ignite liquid monopropellant missile and rocket fuels has been obtained by propellant research specialists at Stanford Research Institute.

An electrolytic liquid monopropellant, hydrazine-mixed with hydrazine nitrate and water, was subjected to electrical discharge from an electrode protruding into the liquid. Various voltages were applied to electrodes of different shapes.

When voltages above a critical value were applied to the electrode, an electrical discharge, apparently similar to gas coronas, was formed at the electrode tip. Lasting about 30 millionths of a second, the corona is believed to consist of streamer-like filaments of plasma.

Study of the corona revealed that when ignition takes place, a self-sustaining reaction zone is formed. Expansion of this zone progressively converts the surrounding liquid propellant into high-pressure, high-temperature explosion products.

By varying the electrode voltage, it was found that the amount of energy delivered per unit volume of the corona is a factor in assuring ignition. Results indicate that at least 15 calories of energy per cubic centimeter of corona are needed. On this basis, it may be possible to obtain ignition with very small coronas and energies as low as one calorie.

SRI's program was sponsored by Army Ordnance and supervised by Dr. Marjorie W. Evans, senior physical chemist at SRI.

X-15 Control Jets To Be Manufactured By Bell

Tiny control jets which will be placed in the nose and wing tips of the X-15 are being manufactured by Bell Aircraft Corp., Buffalo. Purpose of the jets is to help the pilot steer the research aircraft once it leaves the earth's atmosphere.

The tiny jets, which are operated by a four-way thumb operated switch, shoot out a vapor created by hydrogen peroxide passing over liquid oxygen. By pressing the switch forward, the jet vapors cause the nose of the plane to drop. Pushed back, the switch allows the left wing to drop.

In the earth's atmosphere, the plane would be steered by conventional methods.



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Dryden Denies "Race" With Reds

by Frank G. McGuire

The probable head of the nation's new civil space administration, Dr. Hugh L. Dryden, now director of the National Advisory Committee for Aeronautics, told a congressional committee that NASA's space program is not aimed at keeping up with or being competitive with the Soviet Union—and that he is opposed to anything like a "crash money program to leapfrog Russia."

Dryden made his comment to the House Select Committee on Astronautics and Space Exploration.

An ARPA spokesman told m/r that NASA's space program before Congress "is practically word for word the program which we spent several months preparing." However, he added, although ARPA had assigned "conservative" costs to its purely scientific space program, NACA, in most cases, cut the figures "in half."

Dr. Dryden declined to encourage the House committee to approve double the amount that was proposed as the NASA budget, even though he said he thought this is what would be needed to overtake Russia in the future. He said the present budget was enough, and there would be ample time to ask for more money when present plans are evaluated.

The President has sent to Congress a request for $125 million in new money, and has ordered the transfer of $117 million from the Defense Department, principally from ARPA (see also p. 74). There is also available the $101.1 million appropriated to NACA. The House and Senate have already approved a $47.8 million authorization bill for NASA equipment and facilities.

The ballistic missile program, Dryden said, has the highest priority, "and I, as well as other people, am more concerned about whether we have a stock of missiles ready to operate intercontinentally, than I am about doubling or tripling the amount of money in the (civil) space program at this time." He said he felt there would be an adverse effect on the military program if too much were diverted into the NASA programs.

Lee Metcalf (D-Mont.) commented after Dryden had testified, that "it would be a tragic thing for the nation if the President appointed Dryden head of NASA."

The committee hearing brought out these points:

Within the next twelve to eighteen months, *Atlas* boosters will be available to orbit satellites of 100 to 700 pounds at altitudes of 300 miles. Dryden said that if an *Atlas* were needed, it would have to be ordered now for delivery in nine months, or else be diverted from the ICBM program.

The 1 to 1½ million-lb.-thrust rocket engine is being transferred to NASA from ARPA as part of the new agency's responsibility. This powerplant is expected to orbit a 40,000 pound payload in a 300-mile orbit.

NASA hopes to have a 100-foot spherical reflector in orbit by late FY 1959 or early FY 1960 for communications purposes.

Specific impulses of 360 seconds have been attained at the NACA Lewis Laboratory using hydrogen and fluorine, and nuclear engines are expected to develop 1,200 seconds specific impulse.

Preliminary tests of a 2,200-pound manned satellite vehicle will get underway soon, with first manned flight possible within a year (though not actually placed in orbit). *Atlas* is planned as launching vehicle, with overall costs being broken down as follows:

Development and construction of models and full-scale (about 7-foot diameter) capsules—$6.5 million.

Instrumentation for model and full-scale flight capsules—$4 million.

Booster systems for five models and two full-scale flight capsules (These include instrumented and small-animal flights)—$19.5 million.

NASA's proposed budget for research and development on advanced components and techniques includes propulsion systems, $30 million; vehicular subsystems, $28.5 million; instrumentation, $7 million; special vehicles, $16.5 million; communications and meteorological satellites, $10.5 million.

Development of midcourse guidance for flights to planets will soon get underway.

NASA wants a stabilized platform in satellites to hold at least 2,000 pounds for mounting of astronomical telescopes. A similar experiment would involve an atomic clock to test the theory of relativity.

The total personnel assigned to NASA will be close to 10,000 persons by 1959. This includes the present 8,200 of NACA personnel and an additional 1,800.

NASA to be Included In Renegotiation Act

In a move virtually assuring Congressional approval, the House Ways and Means Committee has reported out a bill to expand the Renegotiation act to include the National Aeronautical and Space Administration and to extend the present act, with only one other change, for another six months. The present Renegotiation Act is due to expire December 31, 1958. The extension would keep present provisions in force through June 30, 1959.

The one change the committee approved would allow private firms to appeal decisions on excess profits to the U.S. Court of Appeals, whereas under present provisions, the U.S. Tax Court is their last resort.

Congressional passage of the bill and a Presidential signature are virtually assured. This does not mean that industry efforts to get present provisions modified have failed. To the contrary, it means that Congress is not satisfied with the bill as it stands and wants more time in which to consider proposed alterations.

NASA Facilities Budget Breakdown

Congress has approved $47,800,000 in new capital facilities for the National Aeronautics and Space Administration. This is in addition to $26,220,000 already approved for NACA, of which the majority is applicable for space research. Here is the capital facilities breakdown:

Wallops Island: Two intermediate range-type rocket launching facilities, $4,680,000 (for testing of hydrogen-fluorine combinations), land acquisition, $600,000; design and engineering services, $537,500; instrumentation of range, $12,500,000; erosion control, $137,000.

Space Projects Center, Beltsville, Md., $3,750,000 including erection of two buildings, equipment and instrumentation.

General equipment and instrumentation for tracking of satellites, $19,500,000. (NASA will take over present IGY network, the Vanguard computing center in Washington, and will make use of optical stations operated by Smithsonian Institution).

Langley Aeronautical Laboratory: High-temperature structural dynamics facility, $12,120,000.

Ames Aeronautical Laboratory: Hypersonic helium tunnel, $1,685,000; hypervelocity research laboratory, $1,450,000; modifications to flight research laboratory, $1,186,000.

Lewis Flight Propulsion Laboratory: Modifications to rocket altitude research tunnel, $512,000; hypersonic missile propulsion facility, $2,690,000; modification of materials research laboratory, $2,080,000; high-energy rocket engine research facility, $1,800,000.

Atlas Reaches Full-Power Tests

by Norman L. Baker

The first successful flight last week of the full powered (three-engined) *Atlas* B is convincing evidence that, although, the missile is far from operational status, it has entered the final phases of the engine flight test program.

Last week's test was only the first in a series of engine compatability tests. Launched with a reduced propellant load, the *Atlas* went through full duration booster engine burning and separation and a limited sustainer engine operation. Sufficient impetus was generated to thrust the missile to an impact 2,500 miles downrange, one-half of its design operational range.

This was the second flight of the *Atlas* B model—the first marriage of the three-engine cluster ended in failure after 45 seconds of flight. The August 2nd flight was the first with an operational nose cone configuration.

• **Testing program**—Many test flights remain before the *Atlas* becomes a working weapon of the Air Force First Missile Division.

For example, an operational *Atlas* flight sequence program will perform the following functions: The vernier engines, located on each side of the missile and approximately one-fourth of length of body from the base, will be ignited five seconds before main engines are ignited.

Main engines (twin boosters and sustainer) will be ignited simultaneously, and quickly develop maximum sea-level thrust. At lift-off from the pad, boosters are producing 150 K each (K equals 1,000 lb.) and sustainer 54 K (total thrust of 354,000 lb.). The vernier engines provide additional attitude control during this phase.

After 140 seconds of burning, the two booster engines, plus the base frame, drop away. By the time of booster burnout, the engines are developing about 165 K due to increased efficiency at high altitude. The sustainer, now with a high altitude thrust of 60 K, continues to burn for approximately another three minutes for a total burning time of five minutes.

During sustainer flight, the verniers supply thrust control adjustment, in addition to roll and attitude adjustment. Thrust of the verniers range from 800-lb. at sea level to about 1 K at upper altitudes.

Vernier engines continue to burn for 15 seconds after sustainer cutoff, to obtain terminal velocity adjustment. At the instant of final velocity attainment, the nose is separated from the missile proper.

Small retro rockets provide clean separation of the nose cone. The retro rockets are solid propellant units supplied by Atlantic Research Corp. The nose cone is then oriented for correct re-entry attitude, probably by small steam jets located on the periphery of the underside of the package.

• **Much depends**—Therefore, the "1½-stage" *Atlas*, actually a two-stage missile, requires the reliable, full duration operation of at least eight separate rocket propulsion units before its payload can be placed within a reasonable target radius 5,500 miles distant. Only four of these engines have been tested for full duration operation. The three main propulsion units must undergo at least two or three more test flights before a full range flight is conducted. The Air Force reports that this is three or four months away.

Finally, the missile will enter the operational nose cone re-entry test phase of the program. The nose cone on the latest flight, although an operational cone in configuration, is not believed to have been fabricated for re-entry endurance. Currently, the operational target date is late 1959.

Convair Astronautics prepared the first preliminary designs for the *Atlas* during 1946-47. Defense Department economy cutbacks in 1947 led to shelving of ICBM development, although Convair continued its studies until 1951 with its own funds. Full recognition and a top priority was assigned in 1954.

First launching of an *Atlas* was on June 11, 1957; and the first fully successful flight came on Dec. 17, 1957.

The Air Force back-up ICBM, the Martin *Titan*, is expected to start static tests at Cape Canaveral within the next few weeks. The 40-foot second stage of the missile was airlifted last week to the test range aboard a C-124 Globemaster. Static tests will await the arrival of the first stage which is still at Denver undergoing vibration tests.

The *Titan*, at the end of the third year of development, is expected to start first flight tests by the end of this year. Reliable sources have stated that the *Titan* development program could have been shortened by as much as 6 months, but was bogged down by indecision of the missile's future. The two-stage 92-foot missile will be a more efficient carrier system than the *Atlas*, a straightforward function of its staging arrangement.

Date Dubious for Lunar Probe

by Donald E. Perry

Advanced Research Projects Agency has serious doubts that it can meet a firing date within the next few days for its first lunar probe.

Late last week, ARPA had made no firm decision on a firing during August of the *Thor-Able* launch rocket, because of incomplete recommendations from other key agencies. However, ARPA Director Roy W. Johnson said at a press conference that an Allegany Ballistic Laboratory rocket had been selected as the third stage, and that a command guidance system would be used in order to achieve higher reliability.

Best time to fire the probe is when the planes of the earth and moon orbits around the Sun are in line. First of these periods is August 17-20, next is Sept. 14-16. With the use of command guidance to put the terminal stage into orbit around the Moon, the chances are probably 30-70 for success.

ARPA emphasized that the first attempt is merely a test of components at altitude, and it is not anticipated that a Lunar orbit will be achieved. However, with a terminal stage triggered at about 50,000 miles from the moon, possibly would orbit—but would make no more than six turns before vectoring into space.

The decision to use the Allegany rocket was made only two hours before Johnson's press conference. The third stage will contain clusters of vernier engines for additional thrust above the needed 25,000-mile per hour escape velocity.

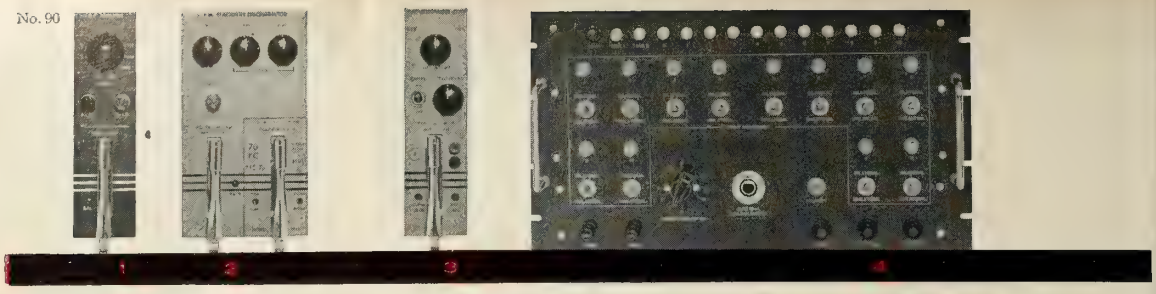
Johnson said the probe vehicle would achieve a speed of about 35,000 feet per second.

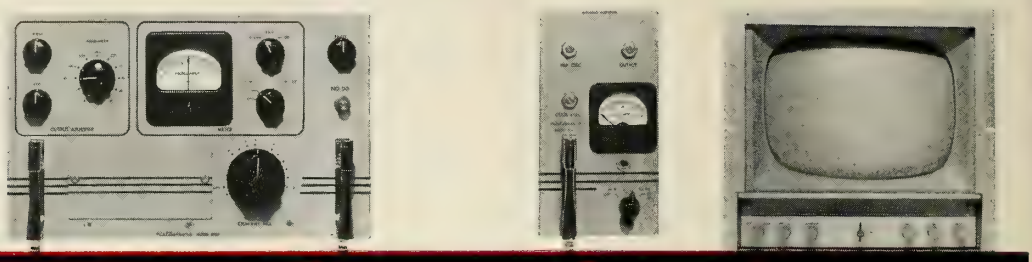
The terminal stage, shaped like a doughnut with the rocket in the center, will be gyro stabilized to allow a photo-electric cell-principle mechanical scanner to take crude photos of the Moon's surface, for transmission to earth electronically.

Payload will be 30 lb. of instrumentation. Although total weight of the terminal stage—to be triggered from the Hawaiian Islands—will be 60 to 65 pounds. More than 50 percent of payload weight will be batteries, broadcast will be on 108 megacycles.

Johnson said that of the five moon shots programmed, the first three will use the *Thor*, but, if one of the two Army probes are ready, in the interim, the Army vehicle will be "put on the pad."

No. 90





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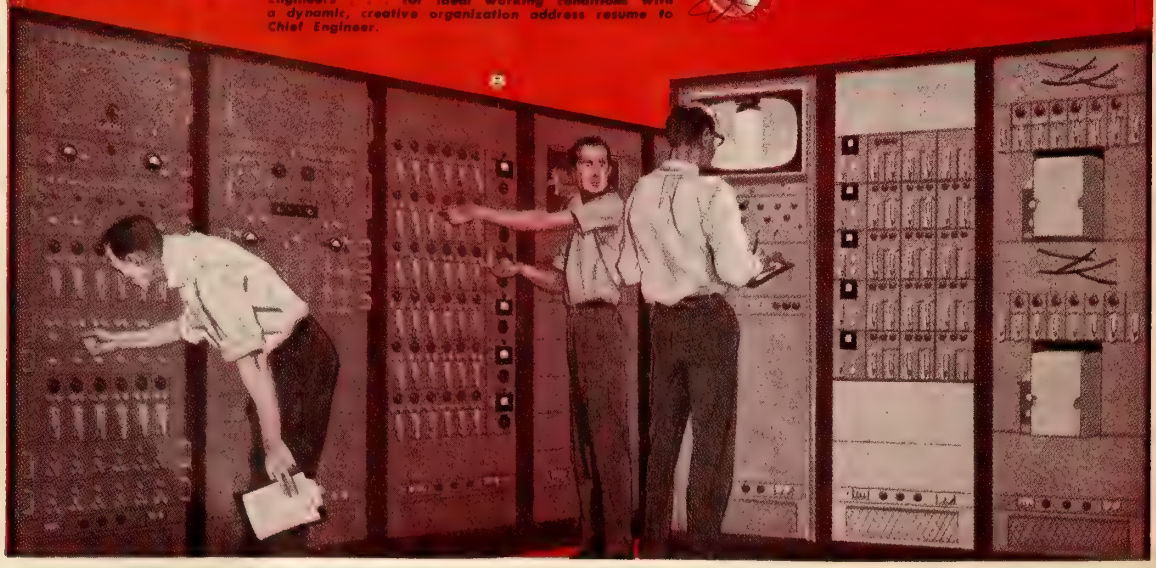
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Manufacturer Gives Funds to Aid Engineer Students

The Aerojet-General Corp. has made a $13,500 grant to the Sacramento State College Foundation, with a view toward helping the college expand its output of engineering students and graduates.

Elmer E. Nelson, Aerojet's resident manager for Administration, said in a letter accompanying the grant.

"These funds are for the purpose of assisting in developing and improving the engineering curriculum of Sacramento State College. The main purpose that our organization has in mind is the acceleration of courses leading to a degree in engineering, so that it will be possible for the college to graduate engineers at the earliest possible date.

"The funds being granted are in no way to be used to supplant or reduce the amount of appropriations being made to the college for its regular operations. These funds are, rather, to supplement and augment such budgetary appropriations in order to achieve the desired ends."

Aerojet is a subsidiary of the General Tire and Rubber Company.

Lockheed Credits Missiles in Biggest Earning Gain

Missile work got a large share of the credit last week for Lockheed Aircraft Corp.'s highest first-half earnings volume.

The corporation's midyear earnings report showed earnings of $9.7 million, a jump of 29% over the $7.6 million in the same period last year. Sales for the first half of 1958 were listed at $465.7 million, up nearly 10% over the $425 million registered in the first half of 1957.

A sales breakdown showed the heavy increase in missile work, amounting to more than a quarter of the total business of the company. Missile and satellite development work stood at 27% of sales, at $123.8 million. Work on five models of Air Force craft accounted for 31%, at $146.9 million.

According to Robert E. Gross, chairman of the board, Lockheed's June backlog of orders stood at $1.215 billion at the end of June this year, compared with $1.280 billion at the end of 1957.

The backlog figure, however, does not include large missile contracts now under negotiation. Lockheed's space vehicle program involves principally the *Polaris* ballistic missile for the Navy and an Air Force Earth satellite; and high-speed target systems for both the Air Force and the Army.



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Explorer IV Most Far-reaching IGY Probe

Instrument-packed Satellite To Find Boundaries, Effect Of Radiation Barrier; May Explain Aurora

by Dr. Ernest Stuhlinger*

Explorer IV was built in a hurry. It has but one mission: to ferret out the mysterious and very intense radiation discovered by *Explorers* I and III near the equator, at altitudes above 600 miles.

Even though indications of this strange radiation was present in the records of *Explorer* I, the high intensity was so unexpected that recordings were at first interpreted as temporary failures of the measuring instruments. The number of rays impacting during every second on the Geiger-Muller counter was so great, that Dr. James Van Allen of Iowa State University, who designed and built the cosmic ray measuring instruments for *Explorers* I and III, thought that the counting circuit did not work properly at times.

The periods of failure happened to coincide with the times at which *Explorer* I was going through the distant portions of its orbit. So *Explorer* III was equipped with a magnetic storage tape which recorded the cosmic ray counts continuously during each full revolution and then played them back quickly while passing over one of the receiving stations.

The cosmic ray counter and the recording and playback devices in *Explorer* III worked for about 40 days. More than 500 playbacks revealed a picture of the cosmic ray intensity which was most alarming.

While the number of cosmic rays measured by the Geiger counter followed the anticipated curve rather closely from the surface of the Earth up to about 600 miles, the intensity took a very steep upswing at higher altitudes. This upswing was steepest in a belt close to the equator. In more northerly and southerly latitudes, it was still far above the expected rate.

• **Higher than expected**—With the counter size used in *Explorer* III, about 70 counts per second could be expected. Instead, the counter reached its maximum counting capability of about 35,000 counts per second at an altitude of 650 miles. *Explorer* III went through a peak altitude of 1,600 miles at its apogee. It is not yet known how many counts an ideal counter would register there but a tentative estimate by Dr. Van Allen indicates that this number may be a thousand times higher than previously assumed.

From all that can be concluded from the measurements of *Explorers* I and III, it appears likely that this newly discovered radiation consists of electrons of relatively low energy. They are emitted by the sun, and they travel in all directions out into space. Those electrons which come close to the Earth fall under the influence of the Earth's magnetic field. Their paths are bent by the magnetic force in such a way that the electrons travel on spirals which follow in general the magnetic field lines. However, the electrons do not continue all the way to the magnetic North or South Pole.

Since the magnetic field strength increases towards the poles, the spirals condense like a compressed spring and before reaching the denser layers of the atmosphere, the electrons bounce back in spirals which again follow the field lines, but now towards the opposite pole. Upon approaching the other pole, the spirals compress again, and finally the electrons reverse their general direction.

In this fashion, they oscillate back and forth on spirals between the magnetic poles. The Earth's magnetic field acts like a trap which catches the electrons and keeps them until they collide with one of the residual air molecules at lower altitudes near the poles.

• **Reason for Aurora**—Such a collision normally causes the molecules to emit visible light and this effect is what is observed as "northern lights" or the Aurora Borealis.

Although the Aurora and its causes have been studied for ages, it was not previously known that electrons are trapped in the Earth's magnetic field in such great numbers.

The Earth's field acts not only as an electron trap, but also as a huge reservoir for electrons. Many of them leak out of this reservoir by collisions with air molecules, but their number is continually replenished from the sun. The average lifetime of an electron in this reservoir is of the order of a few hours.

It is estimated that an area of one square inch, at an altitude of 650 miles above the equator, is hit by about 50 million electrons per second. The energy of these electrons seems to be relatively low, mostly of the order of 0.1 million electron-volts. They can be absorbed by even a thin layer of metal or plastic, but many of them produce X-rays in such an absorbing layer. The radiation measured in the *Explorers* I and III experiments consists actually of these X-rays.

• **Far reaching effects**—The implications and consequences of this high altitude radiation are far-reaching. Geophysicists will be able to understand the heat balance of the atmosphere much better than they do now. Problems like long-range weather forecasting or climatological predictions would be much easier to solve if we knew more about the total energy influx into the atmosphere.

The significance of this new radiation for the development of space travel is very obvious. Depending upon its intensity, energy and distribution, our future space vehicles may have to be surrounded by radiation shields, not only to protect the human space travelers but also to keep photographic films, transistors and insulators from being over-exposed to radiation. Even radio communication between space vehicles and Earth may be influenced by this abundance of cosmic electrons.

The satellite carries two Geiger counters, one with a thin lead shield around it, the other one unshielded. Their counting rates are reduced by electronic scalers in order to alleviate the problem of signal transmission by radio.

In addition to the Geiger counters, the satellite is equipped with two scintillation counters. These instruments contain a translucent crystal of cesium iodide or sodium iodide, or just a piece of clear plastic. This so-called scintillator is mounted in front of a photo-multiplier tube. When an electron, or another particle, or even a photon strikes the scintillator with sufficient energy, a minute light flash of extremely short duration is excited.

There is no tape recorder on *Explorer* IV. The data is transmitted continuously by two transmitters, one phase-modulated, the other amplitude-modulated. Each transmits the signals of all four counters. A considerable number of ground stations are ready to pick up and record the signals.

They are spread out over the whole globe. From Chile to Alaska, and in each of the four other continents, there are receivers operated by International Geophysical Year crews, by military stations, and by universities. They will record the satellite signals on tape and ship the tapes to Iowa State University.

**Director, Research Projects Laboratory, Army Ballistic Missile Agency.*

Editorial Promotions Announced for m/r

Promotion of Erik Bergaust to the position of editor of MISSILES AND ROCKETS magazine and appointment of Col. F. Clarke Newlon, who retired from the USAF July 31, as executive editor, has been announced by Wayne W. Parrish, president and publisher of AMERICAN AVIATION PUBLICATIONS.

Col. Newlon, who succeeds Mr. Bergaust as executive editor, effective September 1, was the assistant to the Director of Office of Information Services, Headquarters, USAF. On continuous active duty from July 1942, he had a series of important assignments in the AF Office of Public Information covering the entire range of Air Force operations, including guided missiles and rocketry.

Prior to entering the armed services, Col. Newlon worked on the Omaha WORLD-HERALD, Kansas City JOURNAL-POST, Chicago TIMES, and the Dallas DISPATCH in various positions, including reporter, city editor and managing editor.

Mr. Bergaust, now editor, was managing editor of MISSILES AND ROCKETS from its first issue in 1956 and was promoted to executive editor in 1957. He is the author of several books on astronautical subjects, a member of the Information Advisory Group to the President's Committee on Scientists and Engineers, and president of the National Rocket Club.

ARPA Future Role Not Clearly Defined

The role of the Advanced Research Projects Agency under the new military Reorganization Act isn't yet defined, it became clear last week from defense sources.

A high defense official pointed out that it has not been resolved whether the new Director of Research, Engineering, will be boss of all research programs; or whether both ARPA and the Director of Guided Missiles will continue to go their own ways, with the Director of Research, Engineering, continuing in an undefined role, working on items not otherwise assigned.

In his original messages, President Eisenhower made it clear that the Director of Research, Engineering, would head all research and engineering within the Department of Defense, working directly under the Defense Secretary. However, at later news conferences, Defense Secretary McElroy said that both ARPA boss Roy Johnson and Guided Missiles Chief William M. Holaday would continue to report directly to him.

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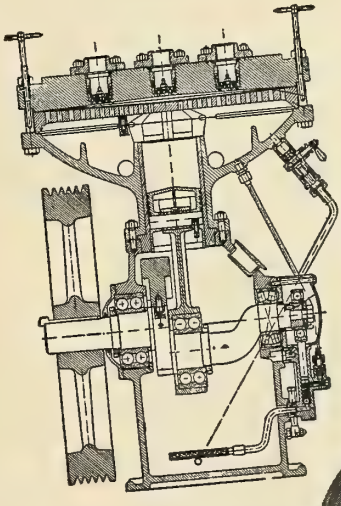
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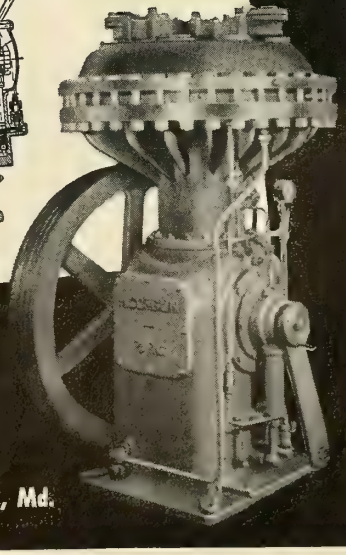
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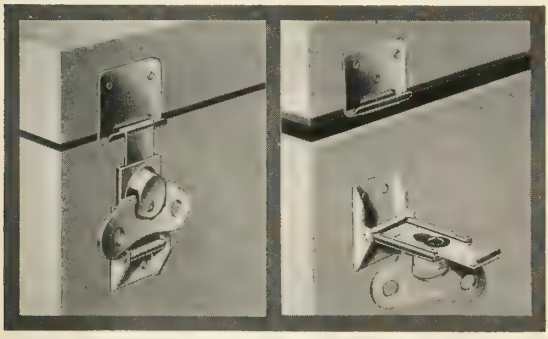
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Major Ultrasonics Firms Merge into New Company

Two leading manufacturers of ultrasonic equipment used in missiles and industrial applications have joined forces through a merger, it was announced last week.

Accoustica Associates, Inc., acquired The General Ultrasonics Company, by issuing 25,872 shares of its common stock to General's stockholders. General will now be operated as a wholly-owned subsidiary of Accoustica, with Stanley R. Rich continuing as president.

The total staff of the two organizations is nearly 300, in seven plants located at Mineola, N.Y.; Hartford, Conn., and Culver City, Calif.

AEC Awards Contracts To Study Space Effects

Forty-five "unclassified life-science" research contracts in the fields of medicine, biology, environmental sciences and radiation instrumentation were awarded last week by the Atomic Energy Commission.

Among them were: A $15,120 grant to Meharry Medical College for a study of the effect of X and Beta irradiation; a $4,607 grant to Yerkes Laboratories of Primate Biology to check into behavioral effects of ionizing radiation; a $7,000 grant to Emory University for studies on the influence of oxygen level and temperature on the effects of ionizing radiation, and a $7,931 grant to the Armour Research Foundation, for a wide-range detector and monitoring instrument.

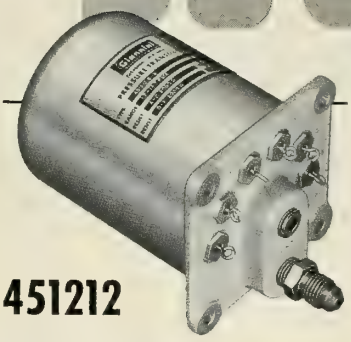
Firms Shift Executives To Aid Missile Manufacture

Organizational changes designed to strengthen firms in the field of service to missile manufacture were announced last week by three major companies.

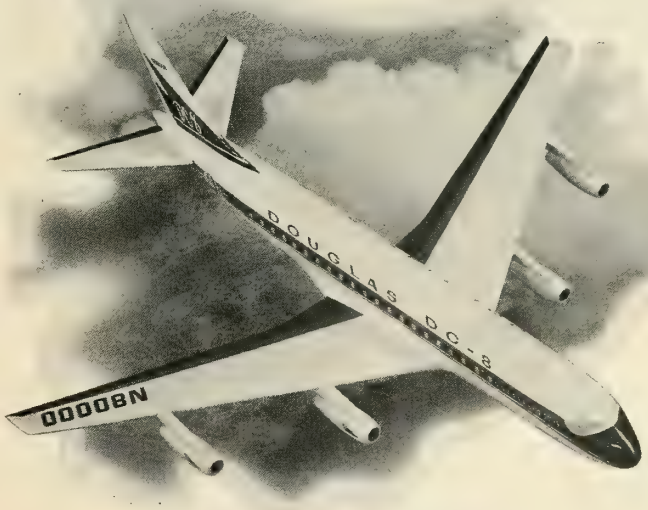
Biggest re-alignment of executive personnel occurred at the Industrial Products Group of Minneapolis-Honeywell Regulator Co., where four major shifts were announced. George M. Muschamp became group vice president-engineering; O. B. Wilson was named group vice president-marketing; John M. Wilson, formerly head of design and development, became director of engineering; and R. L. Mallory was appointed sales manager.

At Santa Ana, Calif., Giannini Plasmadyne Corp. named A. C. Ducati vice president in charge of development engineering; and at Northrop Aviation, Robert R. Miller and Thomas V. Jones were elected senior vice-presidents, with authority in the fields of general operations and planning.

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Science Academy Sets Up 16-Man Space Board

A 16-man Space Science Board has been created by the National Academy of Sciences to act as focal point for all Academy Research Council space activities. It will coordinate its work with civilian and government agencies and with foreign space science groups.

The board will assess scientific research opportunities in the field and advise agencies and organizations on their space research problems. Dr. Lloyd V. Berkner, chairman of the new board, emphasized that participation of private research institutions and universities would be encouraged.

"While government participation is essential, we feel that it would be unwise if space science were to be developed entirely within the bounds of government activity," he said.

Berkner, who is president of the International Council of Scientific Unions, said the board would work with the council and with other international organizations to prevent contamination of the moon and other planets through earth space vehicles.

The twelve committees, which will operate under the board's direction are: Geochemistry of Space and Exploration of Moon and Planets—Chairman, Dr. Harold C. Urey, Professor of Chemistry, University of California; Astronomy and Radio Astronomy—Chairman, Dr. Leo Goldberg, Department of Astronomy, University of Michigan; Future Vehicular Development—Chairman, Dr. Donald F. Hornig, Professor of Chemistry, Princeton University.

International Relations Field—Chairman, Dr. W. A. Noyes, Dean of the College of Arts & Science, University of Rochester; Immediate Problems (space laboratories, orbits, liaison with IGY)—Chairman, Dr. R. W. Porter, Chairman, USNC IGY Technical Panel on the earth satellite program and consultant General Electric Co.; Space Projects (long range planning)—Chairman, Dr. Bruno B. Rossie, Professor of Physics, Massachusetts Institute of Technology.

Ionosphere—Chairman, A. H. Shapley, physicist, National Bureau of Standards; Physics of Fields and Particles in Space—Chairman, Dr. John A. Simpson, Professor of Physics, University of Chicago; Future Engineering Development Beyond Available Facilities—Chairman, Dr. O. G. Villard, Jr., Professor of Electrical Engineering, Stanford University.

Meteorological Aspects of Satellites and Space Research, U.S. Weather Bureau; Psychological and Biological Research—Chairman, Dr. H. Keffer, Hartline, Biophysics Section, Rocke-

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feller Institute for Medical Research; Geodesy—chairman to be selected.

Dr. Hugh Odishaw, the Academy-Research Council's executive director of the National Committee for the IGY, will also serve as executive director of the new board.

McElroy to Choose Between *Nike-Hercules* or *Bomarc*

A recommendation calling for DOD to choose between *Nike-Hercules* or *Bomarc* was included in Congressional approval of a $1.6 billion military construction authorization bill. In voting 80 to 0 to approve the bill, the Senate went along with a committee reduction of 20% in the combined total fund request for the two missile systems.

The committee allocated the funds for the two systems' launching sites to the Secretary of Defense, instead of to the Army or Air Force, thus handing him the burden of final decision between the two.

Facilities for the *Nike-Hercules, Hawk,* and Missile Master control system accounted for $137 million of the Army's total authorization request in construction. About $92 million of the Air Force's funds were slated for *Bomarc* facilities.

Instead of granting the funds to either service, the Senate allotted 20% less than the combined total, or $183,000,000, to the Defense Secretary. He is authorized to construct the missile sites which he deems necessary.

Dutch Firm to Enter Guided Missile Field

Fokker Aircraft is planning to enter into production of guided missiles sometime between 1960 and 1966. F. J. L. Diepen, commercial manager of Fokker, said that the company expects one more generation of manned fighters before air defense becomes the sole domain of guided missiles.

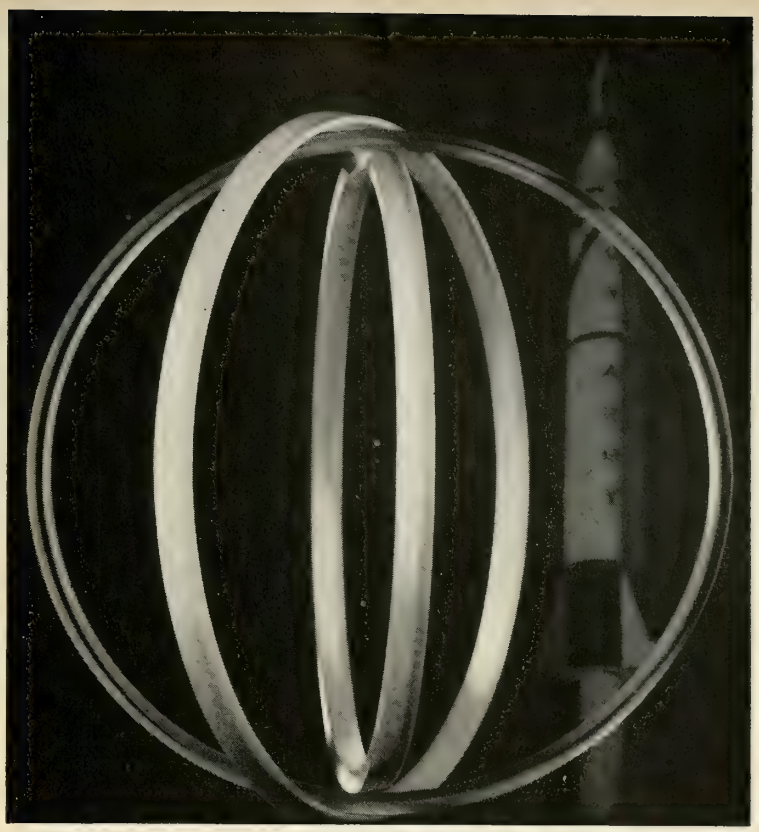
Diepen said it is "unthinkable" that Fokker would undertake development of a new type missile on its own.

Navy OK's Contract For Pyroceram Radomes

A $400,000 contract to the Corning Glass Works will permit the company to add to its facilities for production of Pyroceram missile radomes.

Awarded by the Navy's Bureau of Ordnance, the contract will permit the company to obtain machine tools necessary for finishing the radomes in production quantities.

Pyroceram, a trademark of Corning Glass Works, is a new crystalline material.



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Instrument Buying Session To Be Held in September

A session of special interest to purchasing agents, "How To Buy Instruments and Automatic Controls", will be held during the 13th annual Instrument-Automation Conference and Exhibit, September 14-19 at the Convention Hall in Philadelphia.

The session, to be held September 14 at the Sheraton Hotel, has been planned, according to Dr. Robert Jeffries, president of the Instrument Society of America, to "further professional ethics of buying and selling instrumentation, and to establish a meeting ground and a common language between the manufacturer and the user."

These three areas will be explored: problems of design in original equipment; choosing system for large utilities, refineries or chemical plants; and the special problems a purchasing agent has in buying instruments and control devices.

The Instrument Society of America will sponsor the five-day conference. More than 450 manufacturers of instruments and control equipment are expected to exhibit.

Nike-Hercules Gyros To Be Produced By Telecomputing

New contracts totaling $1.8 million have been received by the Telecomputing Corp., Los Angeles, from the Western Electric Co. for production of gyros to be used in the *Nike-Hercules* ground-to-air missile, it has been announced.

Telecomputing's Whittaker Gyro Division, located in Van Nuys, Calif., will produce both rate and position gyros for the new missile contracts.

Steel Prices Hiked To About $4.50 Per Ton

A new round of price increases is in the works in the steel industry, it has been announced. Six major steel companies—Republic Steel Corp.; Jones & Laughlin Steel Corp.; Armco Steel Corp.; National Steel Corp.; Pittsburgh Steel Co.; and U.S. Steel Corp.—have announced hikes of about $4.50 a ton to an average price of about $150 a ton.

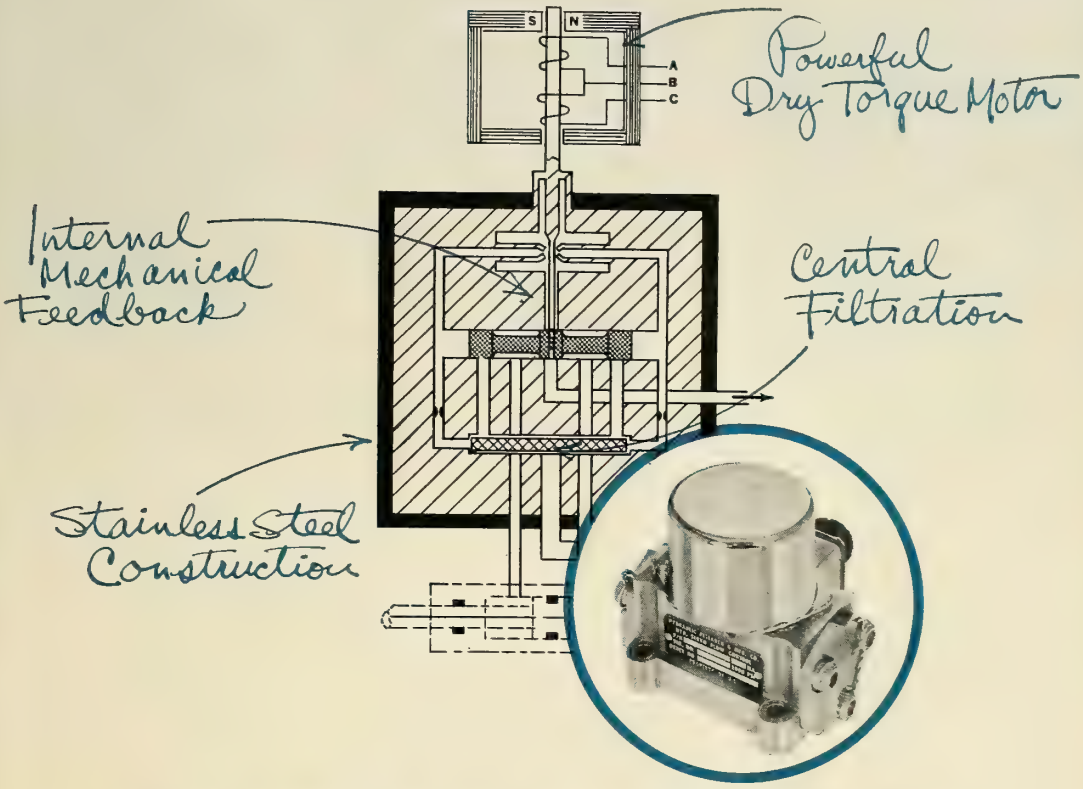
The increases were $3.50 a ton on hot rolled sheets; $4.50 on cold rolled sheets; $3.50 on hot rolled strip; $5.50 on cold rolled strip; and $4.50 on electrozinc-coated sheets.

The companies say a $4.50 per ton boost is designed to offset higher wage costs that have taken effect.

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An m/r special report

Solid Fuels Vie For Propellant Lead

by Alfred J. Zaehringer

SOLID PROPELLANT ROCKETS, now riding high on the crest of increasing missile applications, face a future of competition with liquids and even with itself. The following m/r report covers the most critical areas for future solid rockets: scale-up, production, new materials and supply, and safety.

With the *Polaris* IRBM already under development and the *Minuteman* solid ICBM receiving the green development light, it is evident that a tremendous scale-up is taking place in the design of solid propellant rockets.

Though the *Polaris* missile will vault solid propellants into the long-range (1,500 miles) realm, there is only a slight scale-up in the actual grain. Length of the two-stage prototype is 26.5 feet and the diameter is 54 inches. The same grain mass is being used for both stages of the test vehicles.

The first stage of the test vehicle is a cluster of four *Sergeant*-type rockets, while the second stage will consist of a single rocket. Total propellant mass may only be on the order of 20,000 lbs.

Operational *Polaris* vehicle grain production will represent a major advance in the state of the art. Total launching weight of *Polaris* is expected to be about 30,000 lbs.

• **Major advance**—Though the *Minuteman* ICBM may have a jury-rig set-up in order to get it started, a major manufacturing advance will have taken place. Present plan is to produce a multi-purpose missile.

The top two stages may be quite similar to *Polaris* and could be used by the Air Force as an IRBM replacement for *Thor* and *Jupiter*. All that would have to be developed is a large first-stage booster, which would have a diameter of about 6.5 ft. and a length of about 30 ft. (m/r July 28, p. 50).

The Stage 1 rocket would deliver about 200,000 lb. thrust for 30 sec. Total grain weight would be on the order of 25,000 lb.—a significant step in the fabrication of truly large solid grains. Total weight of the three-stage *Minuteman* would be about 65,000 lb.

It is probable that the propellant will be standard ammonium perchlorate-rubber fuel-binder composite. However, there is the possibility that a slight performance increase may be sought by the inclusion of fuel additives such as aluminum, magnesium, boron, or one of the boron hydrides.

If the solid propellant advocates are able to use these propellant advances, then a considerable improvement in the solid ICBM can be effected. Carrying a 2,000 lb. warhead, the optimum solid ICBM would be only about 50 ft. long, and have a diameter of about 5.5 ft. Total weight would be about 95,000 lb.

Savings in package size—but not weight—would result from a higher propellant loading (90-95%) giving a better mass ratio, possibly higher specific impulse (around 275 sec), and higher combustion temperature. Development of such an optimum solid ICBM would be about half the cost involved in the development of either the *Atlas* or *Titan*.

Production cost would also be lower, but only by a small percent. Very significant savings would be evidenced in the solid ICBM because of negligible handling and maintenance as compared to the complex liquid rockets.

• **Booster breakthrough**—It is quite possible that solid rockets would be used as boosters for space aggregates. However, for launching atomic rockets or ion vehicles, the development of a solid booster delivering about one million lb. thrust would be most valuable.

The solid space booster could be ready in about ten years; based on the advances and scale-up now taking place within the solid propellant industry. Length would be about 70 ft., and diameter about 7.5 ft. Total booster weight might be expected to be 300,000-500,000 lbs., with a total delivered impulse of 60-70 million lb-sec.

By 1970 *all* terrestrial rockets will be solid propelled. This includes: surface-to-surface, surface-to-air, air-to-air, air-to-ground, medium range artillery, IRBM, ICBM, and possibly even cruise missiles.

Aeronautical applications would include boosters for satellite rockets and space missions, vernier rockets, retrorockets for re-entry vehicles, and possibly boosters for extra-terrestrial planetary escape.

Production of modern solid rocket propellants—whether homogeneous or composite—hinges on machinery know-how and application. Modern solid propellants can no longer be hand-made. Production rates, safety considerations, and quality control specifications are all necessary to assure that solids stay in the rocket race.

Practically all the variables responsible for the success or failure of a solid propellant are now tied to operating characteristics of a particular machine. Thus, hand methods have been thrown out the window as solid composites and homogeneous propellants have finally relegated "powder rockets" to a dying Fourth of July black art status.

This does not mean that the solid propellant business is entirely free of the black art. It has been said that what is not classified is in the trade secret domain. For example, if the Russians were able to obtain secret reports revealing exact propellant compositions, they would still be unable to produce propellants without knowledge of what machinery is being used and how the machinery is utilized.

It is a well known fact that all major solid manufacturers of composites use much the same machines (see table—p. 29)—but how the machine is used is something that only a few people know.

• **Homogeneous first**—The homogeneous propellants (single and double base) first crystallized the need for modern machinery. Reactors and nitrators were needed to produce nitrocellulose, nitroglycerin, and diethyleneglycol dinitrate.

Various techniques were evolved to work these materials into propellants. Standard and specialized mills and mixers were utilized for solvent, plasticizer, stabilizer, and hot working or "colloiding." After standard extrusion or casting, specialized equipment (propellant slicers, inhibitor wrappers, and grain trimmers) had to be evolved.

During World War II, the production rate for rocket solventless double-base propellants was some 20 million pounds per month. Overall, machines produced over 100 million pounds per month of all homogeneous solids (for rockets and guns).

With the trend toward composites, the double-base solid industry today is working far under capacity. In fact, many of the World War II rocket pro-

pellant plants have either fallen into disrepair or have been dismantled. However, some are still being maintained on a R-day basis.

It is estimated that, at the most, some one half to one million pounds per month of double-base rocket propellants are being made. Most of this propellant goes into the small rockets such as *Mighty House, Zuni,* Army artillery rockets, bazookas, recoil-less guns, the *Honest John, Nike* boosters, and the *Deacon* rocket.

All of the homogeneous propellants are being made at government or contractor-operated government arsenals. The machinery is well defined and marked with government specifications. Most of the machinery market today is for composite propellant production.

• **Composites next**—The great break away from gunpowder occurred during World War II when the potassium perchlorate (Aerojet) and ammonium picrate (NDRC) propellants started solids on their rise to flame and glory.

The perchlorates—first the potassium salt and now the ammonium compound—were amenable to machinery control. By coupling these materials with plastic fuel-binders to produce castable propellants an immediate production revolution in solids began to open up.

Standard and readily available machinery could be used. In addition, propellant specifications could be tied to the machinery. For example, oxidizer specifications are given simply as a particular flow rate at a given hammer speed and given screen size with a given puliverizer. This not only makes conditions reproducible, but when scale-uptime comes, the same conditions for the same machine design will generally produce similar results.

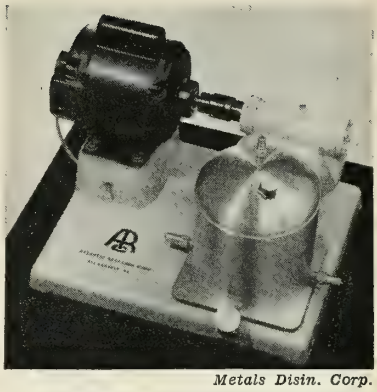
Various mixers are used. In most instances, the dispersion blade types are used for the heavier viscosity mixes and the sigma blade types for the so-called castable propellants. Standard units range from laboratory mixers of a few cubic inches working capacity to large mixers with capacities of several hundred gallons.

It is now possible to produce single batches today of one to three tons of composite propellant at a single crack. On a normal shift basis, a 300 gallon mixer might produce some 100 tons of finished propellant in a month. Add several of these mixers, or use a larger one, and it would be possible to turn out enough propellant to fill an IRBM or ICBM.

In addition to propellant mixers there are now required specialized mixers for producing liners, inhibitors, and for pre-processing fuel-binder polymers. Minimum equipment needed to set up a laboratory level composite line would be an oxidizer pulverizer and a mixer—such as the sigma type—the two costing new from one to ten thousand dollars depending whether gram or pound batches are required.

• **Cast or extrude?**—It takes quite a machinery set-up to extrude propellants. However, it pays off in a high production rate and low unit grain cost. Casting is generally cheaper when production runs are short or where the propellant composition must be frequently changed to meet new performance demands.

Machinery and facility investment for extruded solids may be two to ten times greater than for a cast process. Setting up a lab-scale extrusion pilot plant may take $10-$100,000 for a gram or pound grain basis. Despite the scale-up that has taken place in extruded grains, cast composites still lead the race in the ability to produce the largest single grain. The largest extruded grain during World War II was about 500 lbs. It is doubtful if a single grain weighing over 2,000 lbs. has been extruded in the United States to date. On the other hand, it is certain that cast grains of at least 2,000 lbs. were produced five years ago. Today, in the USA and USSR, a single cast grain of at least 5,000 lbs. has been produced. It is believed that it is possible to produce a single cast composite grain of at least 25,000 lbs. (with successive batches) to give grain impulse potentials of about six million lb-sec.



Metals Disin. Corp.

POTASSIUM perchlorate oxidizer.

• **Batch or continuous?**—Considerable interest is developing in continuous mixers for propellant production. The advantages of production in a continuous stream are many. Remote station, automated control is particularly adaptable to continuous mixers.

One of the less desirable features of batch type mixers is the large quantity of material being mixed. And, as the material is being mixed, the potential hazard increases because all conditions for combustion except the spark are present. Should a fire or explosion occur, the smaller the quantity of material in a piece of machinery the better.

For this reason, continuous mixers which have only a small quantity of burnable propellant in them at a given time are of interest. Then, the newer fuel-binders of ten have pot-life limitations which mean critical mixing cycles. And such critical mixing cycles get worse with big batches.

Further, the development of larger size propellant grains has introduced the problem of combining the output of several batch mixers at the right time and still maintaining a uniformly mixed material. However, batch mixers are still the mainstay of the propellant production industry, but considerable development work is going on.

Continuous and automated propellant production will allow high production rates at low cost and at the same time improve quality. Continuous nitrators are already going into operation for the production of double base materials. Coupled with continuous maxing and extrusion, it may be that the homogeneous propellants will be first to operate on a continuous basis.

• **Machinery requirements**—The solid propellant people rely heavily on

Machinery for Solids

Homogeneous		Composite	
1. Reactors	Preparation	1. Dryer	Oxidizer
2. Nitrators		2. Pulverizer	
		3. Sifter	
		4. Blender	
3. Colloid Mill	Colloiding	5. Planetary ("kitchen") Mixer	Fuel-Binder, Liners, Inhibitors
4. Heavy Duty Mixer		6. Pony Mixer	
5. Roll Mill		7. Colloid Mill	
		8. Roll Mill	
		9. Dispersion Mixer	
		10. Sigma Mixer	
6. Extruder	Grain Production	11. Muller	Propellant Mixers
7. Slicer		12. Sigma Mixer	
8. Inhibitor Wrapper		13. Dispersion Mixer	
9. Trimmer		14. Extruder	

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machinery. As the use of solids increase, the use of machinery will go up. A lab pilot plant may require several thousand dollars worth of just one or two machines. It runs into the hundreds of thousands when you get into actual production equipment.

Most solid propellant process engineers have placed heavy reliance on "pet" equipment. When the scale-up comes it is already written in terms of a particular machine. Therefore, despite the fact that solid propellant production will go up, the machine manufacturers who will benefit will be a rather small, proven lot.

However, there exist other machinery requirements. When you consider the metering, control, and handling equipment associated with propellant production, these total greater than the few basic machines actually used in production.

For the primary production machine manufacturers, it is best to get in with the process engineer on the ground floor—when development is still in lab. That's the way to rise in the solid propellant machinery market.

• **Machinery a key**—Production of ammonium perchlorate, a vital oxidant for high energy solid propellants, will probably be tripled with such missiles as *Nike-Hercules, Nike-Zeus, Sergeant, Pershing* and *Polaris* using the oxidant.

A year ago, there was only one large-scale producer of ammonium perchlrate (AP). The Navy's plant at Henderson, Nev., operated by American Potash and Chemical Corp., was producing only 3,600 tons of AP, and about 3,000 tons were going into small rockets.

But the swing to larger solid rockets brought new uses for AP, and early this year the following two new firms entered into production.

HEF, Inc., a combination of Hooker Electrochemical and Foote Mineral Co., will produce AP at Niagara Falls, N.Y.; Tacoma, Wash.; or Montague, Mich. With Foote's lithium background, it is likely that lithium perchlorate also may be produced. However, the immediate need is for AP.

Pennsalt Chemicals has announced that it will produce AP at Tacoma and at another undisclosed site in the South.

In addition to plant dispersal, the new AP plants will tie in better with existing propellant plants—particularly in the Eastern states and South. Those plants that will benefit from the AP supply line will be the Thiokol-RMI complex in New Jersey and Maryland; the Thiokol plants at Redstone Arsenal and Longhorn, Texas; Atlantic Research in Virginia; American Rocket in Michigan; Olin Mathieson and Propellex in Illinois; and possibly Thiokol in Utah.

California supply lines to Aerojet and Grand Central will not be shortened, although it may ease supply and cause price reductions. Other chemical producers are looking at AP. One large concern has been working with a new AP process for some time; another medium-sized electrochemical firm, while not producing perchlorates, has been carrying out an AP R&D program.

• **Capacity increase**—It is not known how much perchlorate will be produced, but a conservative estimate is that production will triple and capacity will be increased tenfold. The late 1959 production rate will probably be 10,000 tons per year, with actual capacity probably 50-100,000 tons per year. This will definitely place AP at the top of the solid propellant production heap.

It will take several years for the next possible solid propellant improvement step—introduction of lithium perchlorate—to catch up with present AP production. But if and when the switch is made to lithium perchlorate, present AP facilities can be used completely or in part to meet expected demands.

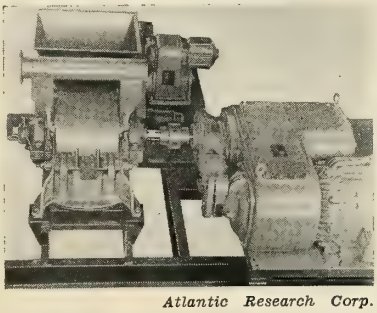
Possibly the Pennsalt plant, and most probably the HEF plant, will be designed as multiple-use or convertible plants for immediate production of AP and eventual production of lithium perchlorate. In either case, until the ozonides or organic solid monopropellants come along, AP will lead the solid field.

• **Missile use**—The following missiles are highly dependant on AP:

Nike-Hercules. The old acid sustainer was replaced by an ammonium perchlorate-polysulfide combination with a burn time of about 30 seconds.

Nike-Zeus. Boost and sustainer both may be slated for AP-polysulfide.

Sergeant. This single-stage solid rocket may use AP-polysulfide.



Atlantic Research Corp.
STANDARD 35 cubic-in. lab mixer unit.

Pershing. This solid replacement for *Redstone* also uses AP.

Polaris. With development well under way, AP is believed to be the oxidant for both Thiokol and Aerojet formulations. Thiokol will probably use polysulfide with high energy additives such as aluminum metal or boron and boron hydride. Aerojet may use its polyurethane with AP and may also resort to high-energy additives.

IRBM. Design studies are probably proceeding assuming AP oxidizer.

Minuteman. The solid ICBM would enormously increase demands for R&D quantities of AP and for production missiles.

Although exact figures outlining AP requirements for missiles may be classified, close estimates have been made. For example, about 10 tons of AP would be needed for a single production surface-to-surface missile of V-2 range and payload capabilities. The actual amount of oxidizer would be about nine tons with perhaps another ton for losses, scrap, small-scale proof testing, physical testing, temperature cycling and long-term storage.

The production figures do not include R&D, which would use many small and full-scale units. USAF asks for about 56 units for full-scale proof or qualification testing; thus using about 600 tons of AP for this phase alone.

Plus figures account for production rockets for training and operational field stockpiles. Training and production requirements could amount to 2,000 tons per year of AP for only one missile. Since only 3,000 tons were produced last year, AP production will have to go up.

• **Lithium perchlorate**—With increasing availability of lithium perchlorate, there is speculation whether it can improve solid propellant performance. Performance undoubtedly can be increased, but the question is—how much and at what price.

Several independent propellant investigators have increased performance of the present 225 seconds specific impulse to over 240 seconds. There are claims that the 270 increase has been reached. However, because of its newness, lithium perchlorate is still in the laboratory league. Whether it gets into the majors is another question.

Laboratory quantities of the salt have been produced by a number of firms—notably Foote Mineral and Lithium Corp. Recently, American Potash & Chemical Corp. started supply.

At present, the salt is made by double decomposition methods, such as the reaction of a basic lithium salt (viz., carbonate or hydroxide) with perchloric acid. This is an expensive and touchy process. It will probably be made by an

electrolytic process similar to the making of ammonium perchlorate. Other production processes are being investigated.

The big advantage of lithium perchlorate is its high density and oxygen availability for combustion. The following table illustrates these features.

Lithium perchlorate supplies more oxygen on a volume or weight basis than either ammonium perchlorate (the present high energy oridant), or ammonium nitrate (a low cost, medium energy oxidant).

Parameter	Lithium Perchlorate	Ammonium Perchlorate	Ammonium Nitrate
Density, lb/ft³	152	122	108
Available oxygen weight %	60.1	34.2	19.5
Melting point F	460	—	340

• **Performance**—On a weight basis, lithium perchlorate has about three times the oxygen content of ammonium nitrate and twice that of ammonium perchlorate. Despite its increased oxygen content, lithium perchlorate is the more stable.

Pure ammonium perchlorate reacts with itself to give a decomposition reaction, and for this reason has no definite melting or decomposition point. This inferior stability of the ammonium perchlorate has caused serious production accidents that possibly will not happen with lithium perchlorate.

The favorable oxygen content, oxygen balance, and stability are all attractive lithium oxidant features. Even combustion temperatures appear to be higher than ammonium salt. Adiabatic flame temperatures for AP propellants range about 3000-4500°F.

However, a disadvantage of lithium perchlorate is that most products would be solids of relatively high molecular weight (see table below) and it is here that performance gains are wiped out.

Product	Molecular Weight	Melting Point, F	Boiling Point, F
Lithium chloride	42.40	1130	2460
Lithium fluoride	25.94	1598	3050
Lithium oxide	29.88	3092	....

The chloride, or in some cases the oxide, would be typical products with lithium perchlorate oxidants and organic fuels. Thus, with completely combustible organic fuels, lithium perchlorate will give a solid exhaust.

The situation (in regard to smoke and high molecular weight exhaust products) would be worse with metals or boron fuels. The table below gives the ballistic performance of lithium perchlorate with various fuels.

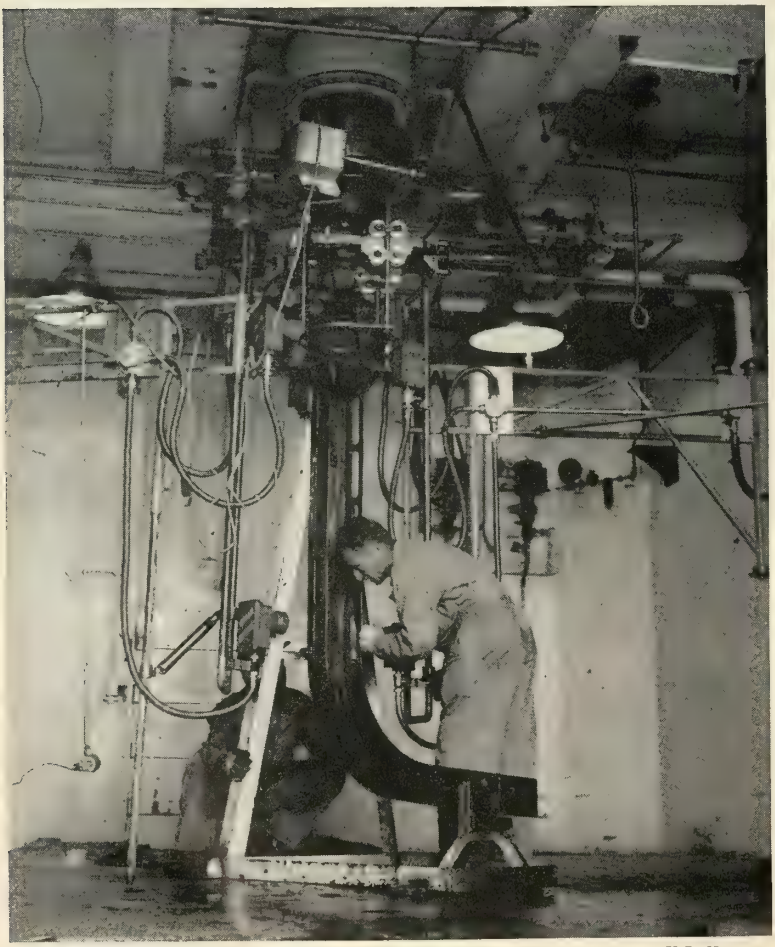
Fuel	Wt. % $LiClO_4$ needed for complete combustion	Propellant heat release (BTU/lb)	Specific impulse (sec)	Typical exhaust products
Organic (taken as C_2H_4O)	75	4,500	250	LiCl, CO_2, H_2O
Aluminum	59	5,400	260	LiCl, Al_2O_3
Decaborane	82	5,050	270	LiCl, B_2O_3, H_2O

As illustrated, use of lithium perchlorate would bring near stoichiometric conditions with organic fuel-binders and yet allow good processing conditions. Using a liquid casting resin, a propellant mix containing 75% lithium perchlorate would be castable. The next step would be adding either a metal such as aluminum, magnesium, or boron; or an additive such as solid decaborane.

Either technique could yield higher performances over the straight organics and yet allow good processing conditions. With an all-born fuel, it is unlikely that the use of lithium perchlorate would allow solids to attain an impulse of 280 seconds. It should be pointed out that the above table may represent an optimistic outlook.

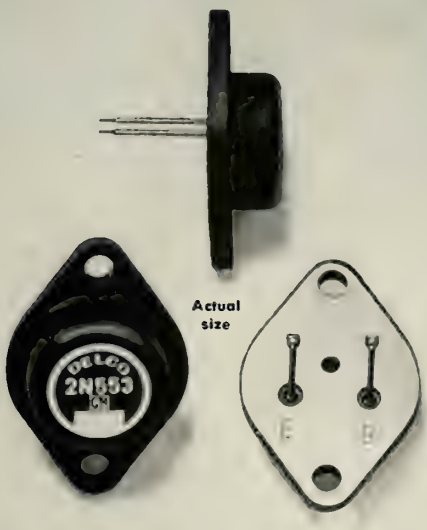
• **Additional factors**—There are several other factors to consider with this potential oxidant. It is hygroscopic, which would lead to processing difficulties. However, lithium perchlorate would probably be no more hygroscopic than ammonium nitrate and processing under low humidity conditions is an accepted technique.

Cost of the lithium salt is high and availability is low. It is estimated that last year only about one ton was made. Therefore, its cost on a pound basis is measured in dollars per pound. Several



U.S. Navy

EXTRUSION of double base grains requires complete equipment at plant.



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Collector current	4 amps. maximum
Base Current	1 amp. maximum
Maximum junction temperature	95°C
Minimum junction temperature	−65°C
Collector diode current I_{CO} (V_{CB} = 2 volts)	12 μa
Collector diode current I_{CO} (V_{CB} = −60 volts)	0.5 ma
Collector diode current I_{CO} (V_{CB} = −30 volts, 75°C)	0.5 ma
Current gain (V_{CE} = −2 volts, I_C = 0.5 amp.)	55
Current gain (V_{CE} = 2 volts, I_C = 2 amps.)	25
Saturation voltage V_{EC} (I_B = 220 ma, I_C = 3 amps.)	0.3
Common emitter current amplification cutoff frequency (I_C = 2 amps. V_{EC} = 12 volts)	25 kc
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of the lithium manufacturers are optimistic about cost in large scale production and feel that it could actually compete costwise with ammonium perchlorates.

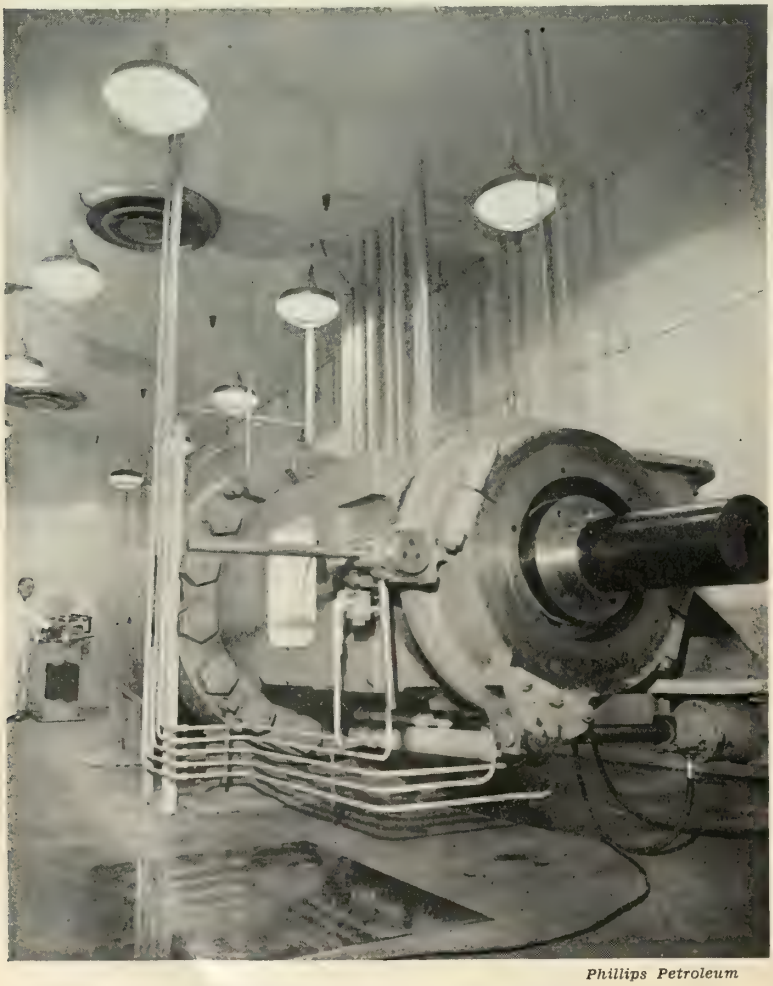
Propellant chemists say lithium perchlorate can give solids an immediate performance increase. Actual amount of this increase is in doubt and probably classified.

Because of molecular weight limitations in the exhaust, it is certain that lithium perchlorate will only put solids in the 250-270 class. Any hopes of nearing 300 seconds will need drastic breakthroughs in preferential or selective oxidation.

It might be possible to selectively oxidize organics to carbon dioxide or monoxide and water and convert the halogen to HC1, keeping lithium at its low molecular weight of 6.94. This will be difficult because of temperatures on the order of 3000°F, 10-100 atmospheres of pressure, and excess oxygen. This illustrates what the solid propellant people are facing to keep up with fluorine or ozone liquid systems.

• **New compounds**—At least two rocket groups are seeking the evolution of new rocket propellants via organic nitrogen compounds. High energy additives for composite and double base solids, and possibly stable liquid monopropellants, could result from the work now in progress at Aerojet and Rohm & Haas.

Aerojet's work seems to be concerned with dinitroethylation—putting the gem-dinitroethyl radical into organic compounds—and winding up polynitroesters and alcohols. This was about all that Aerojet reported at the American Chemical Society meeting in San Francisco in mid-April.



Phillips Petroleum

OPERATOR CONTROLS extrusion of ammonium nitrate grain.

It is believed that the new compounds might have immediate applications in polyurethane fuel-binders where either higher energy content or higher burning rates might result.

Nitrogen also is the key to new synthetic organic monopropellant materials being evolved at Rohm & Haas, Research Division, Redstone Arsenal. The organic group has published a wealth of unclassified material concerning its organic syntheses.

Most of the work is concerned with nitration and nitro compounds. However, recent work with fluorine and the boron hydrides indicate that an entire new class of high energy compounds might result.

Solid propellants, however, may become classless in the future when composites incorporate new monopropellant materials into their mixes and the homogeneous propellant people utilize high energy additives. Aerojet, for example, is already reported to be incorporating aluminum into their composites. Next step will be nitrated plastics. Hercules Powder may resort to adding the borons to their double-base propellants.

According to specialists, only about one ten billionth to one billionth of the mass of chemical fuels disintegrates into energy. Thus, the solid people (and the liquids too), will have to look to new mechanisms of energy release than foolishly seek new compounds. For it is a well known fact that the performance of all known or possible chemical compounds fall within a narrow band in the rocket spectrum.

The rapid scale-up of solid propellant rockets may mean trouble for solid propellants if the concept of "critical diameter" is established. A propellant which normally cannot be detonated might detonate when a certain size is exceeded.

This is a definite danger, according to Dr. John Hyndmann of the Ballistics Section of the Rohm & Haas Co., Redstone Arsenal Research Division. Dr. Hyndmann refers to the general conditions required for transition from normal burning to detonation as set forth by Kistiakowsky during the Third International Symposium on Combustion and Detonation Phenomena.

His proposed mechanism involved ignition of a granular bed of explosive, arranged in order that products of combustion were able or forced to pass through the bed. The resistance to gas flow through the bed results in a pressure build-up and more rapid burning, causing greater flow.

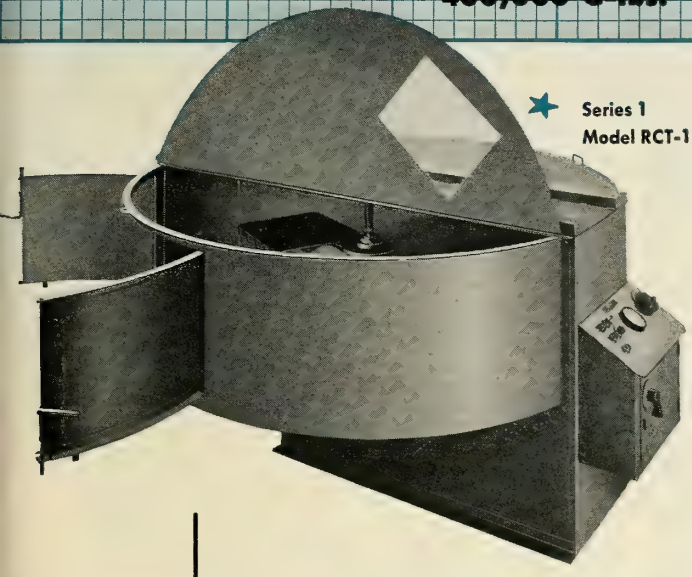
Eventually, the formation of shock waves might be sufficiently intense to become detonative or reactive shocks, and consume the rest of the bed as a detonation. This process has been ob-

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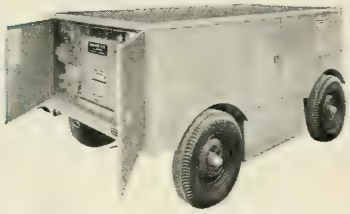
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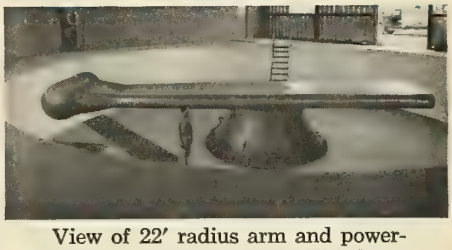
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★ **Series 20 Model RCT-21**

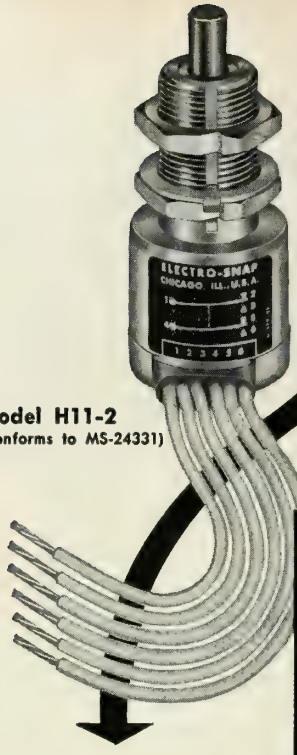


View of 22' radius arm and powerhead installed in test pit. This large Series 20 unit is designed for testing 4,000 lb. specimen at 100 G-rating.

Circle No. 17 on Subscriber Service Card.

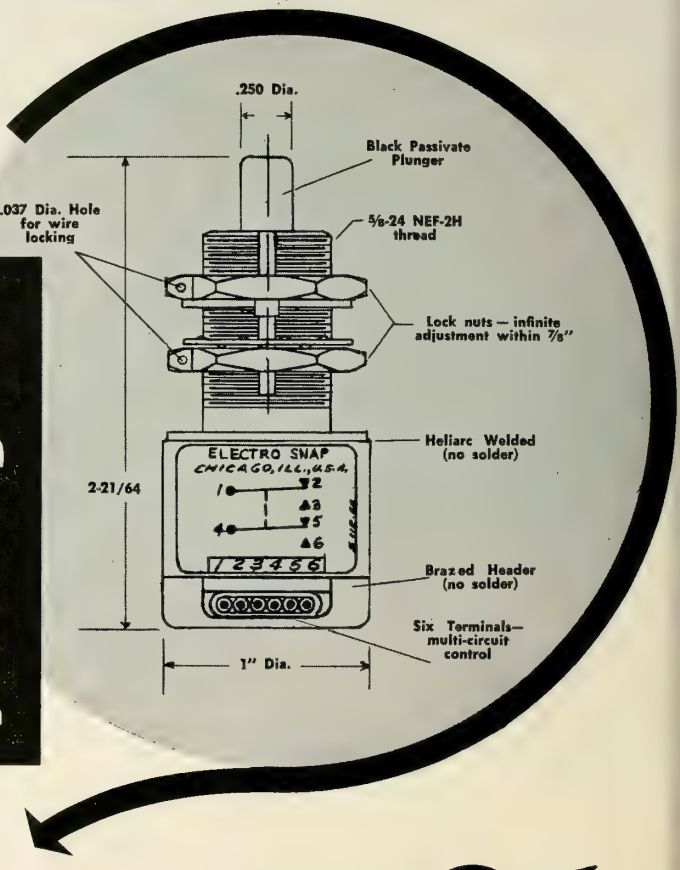
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operating characteristics

Contact Arrangement	2—S.P.D.T.
Pretravel	.040 Max.
Movement Differential	.020 Max.
Overtravel	.250 Min.
Operating Cycles	25,000 Min.
Break Distance	.010 Min.
Difference of Operating & Reset Pt. Between Each Pole	.010 Max.
Operating Force	9± 3 Lbs.
Overtravel Force	30 Lbs. Max.
Release Force	4 Lbs. Min.
Electrical Rating — Sea Level to 100,000 Ft.	28 VDC, 4A Res. 2 A. Ind. — 4A Motor
Ambient Temperature Range	−100° to +221° F.
Weight	2¾ Oz. Approx.

ELECTRO SNAP

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served in finely divided beds of double base and composite propellants under test conditions.

It has been concluded that the transition from burning to detonation is a physical condition rather than the chemical make-up of the propellant. Three conditions, usually present in all propellants, are ignition, interconnected porosity, and detonatability.

• **How it works**—Applying the concept of critical diameter to propellants, Dr. Hyndmann illustrates the case thus: materials such as azides and fulminates need less than a millimeter of diameter to detonate. Cast TNT needs about a centimeter. Ammonium nitrate needs about 30 cm.

Thus, the elation some composite manufacturers have concerning the safety of their propellants is a result of having tests conducted with sample diameters under critical conditions.

The Texas City disaster of 1947, where tons of ammonium nitrate first caught fire and then detonated, illustrates the concern that the armed forces have when considering the use of large solid propellant thrust units. Not only the effect on military personnel, but possible effects on the general public, must also be considered.

Ignition is always at hand in a solid propellant, so the other item of concern is porosity. The most likely causes of detonative-inducing porosity are listed as:

1. Shrinking of the fuel-binder during cure (after gel), which results in strained areas at star points and sharp corners.
2. More strain when the propellant cools from cure to room temperature.
3. Separation of oxidizer from fuel-binder, due to wide differences in coefficient of thermal expansion.
4. Separation of oxidizer from fuel-binder because of different coefficient of compressibility when the propellant is pressurized on ignition.
5. Strain on the propellant due to strained metal motor case.

Generally these conditions are more severe at low temperatures and can lead to actual cracks. However in large masses, non-visible strains can also lead to malfunctions.

In order to minimize the probability of the transition from burning to detonation, Dr. Hyndmann suggests that the following measures must be taken:

1. Operate the rocket motor only at a temperature where malfunction is unlikely.

2. Improve the physical properties of the propellant to a point where the strains can be safely tolerated. For homogeneous propellants, this applies to the entire composition from composites to fuel-binders.

3. Bring the propellant up to full pressure more slowly to minimize strain during first firing.

4. Use good design in motor or grain to minimize strain on propellant.

• **Can't hide problem**—Solid propellant advocates will have a hard time in sweeping this critical matter under the liquid-solid race rug. George S. Sutherland of the Boeing Airplane Co., Seattle, Wash., estimates that by 1960 the large scaled-up solid rocket will be over 90% propellant with a rocket weight of about 100,000 lbs.

The solid ICBM, Sutherland figures, will be about 50 tons in weight, and a one-way moon rocket will tip the scales at 280 tons.

Whether the grains are homogeneous or composite, cast, extruded, or cemented, it will mean a large chunk of propellant that could approach the critical diameter needed for detonation. Thus, solids will probably have to be staged at less than optimum conditions to prevent detonations in very large masses.

At a recent guided missile symposium, Standford Research Institute's N. Fishman, R. B. Foster, and I. W. Yabroff presented yet another solid propellant problem—solid propellant aging and missile reliability. Though solids deteriorate at a very slow rate, it can lead to performance variations that are particularly critical in large rockets or for long storage times.

Aging may be a result of many different factors, depending upon the composition of the propellant and its reaction to its storage environment. In most cases, the result of aging is degradation of the polymeric binder-fuel, with indirect effects on the ballistic performance of the system. Elevated temperature, oxidation by storage in air, and reaction with moisture in the air are the most usual causes for changes due to aging. Creep, chemical interchange, or other phenomena, which are inherent characteristics of the propellant binder, may also occur.

All of these considerations indicate that the solid-liquid struggle will continue hot and fast for the next ten years at least.★

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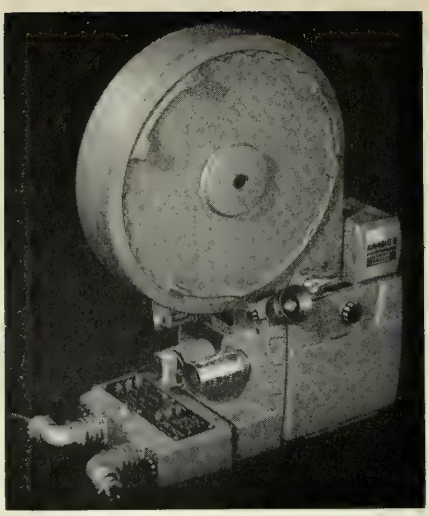
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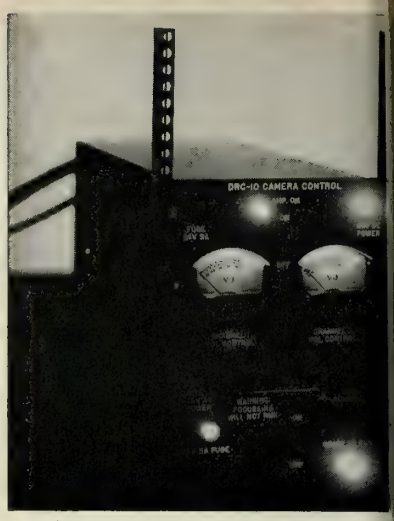
MISSILES AND ROCKETS
Magazine of World Astronautics
1001 Vermont Avenue NW,
Washington 5, D. C.



AMERA with plug-in control unit for emote use showing magazine interior.



DATASYNC has plug-in amplifier for non-remote use. Footage counter rotates.



DRC-10 control unit for remote use Color lights show operational mode

Recorder Offers Speedy Data Processing

by Richard Van Osten

A problem long familiar to test and instrumentation engineers is that of extracting urgently needed data from the complex mass of information gathered during operational evaluation of a system or component.

One device offered as a possible solution to this difficulty is the new DATASYNC recorder developed by Berndt-Bach, Inc., Los Angeles, Calif.

• **Operation**—Currently in use by Convair-Fort Worth and also under study in classified tests at Wright Air Development Center, The Datasync uses standard 16-mm motion picture film that can be pre-striped for as many as ten magnetic sound tracks.

A self-synchronized readout of electrical, visual and audio data is almost immediate within minutes after recording, by use of modern, high-speed, automatic film processing machines.

As the camera takes motion pictures of a missile launching or a high-speed rocket sled run, for example, the film's magnetic tracks are fed instrumentation signals. The feed-in unit, a transistorized multi-channel amplifier, may be remotely located or plugged directly into the camera base.

Amplified and impedance-matched, the signals are fed to recording heads in the camera's film chamber. In a 10-track setup, there are 10 individual recording heads, each equipped with a reproduce head for monitoring the sound track 1/50th of a second after data has been recorded.

Striped for five tracks, the magnetic area can record some 60,000 data bits per second, based on the frequency response of 50 to 12,000 cps. It may also be used to provide a broad-band response from DC to 12,000 cps. Loaded with its present capacity of 1,200 ft. of film, the device can record up to 240 million cycles of analog or digital information synchronized with 48,000 motion picture frames. If properly programmed, a single track may record and readout 300 or more instruments per second.

Regardless of five track or 10 track configuration, a single "balance track" is applied between the film's edge and the perforations. The remaining tracks (four or nine) are laid down between the opposite edge and the film frames. Each track is approximately 0.018-in. wide, and separated from an adjoining track by 0.005 in. The tracks are not affected by the developing process.

• **Use in the field**—Datasync equipment may be adapted to use both magnetic and optical tracks, or both, depending upon the user's requirements.

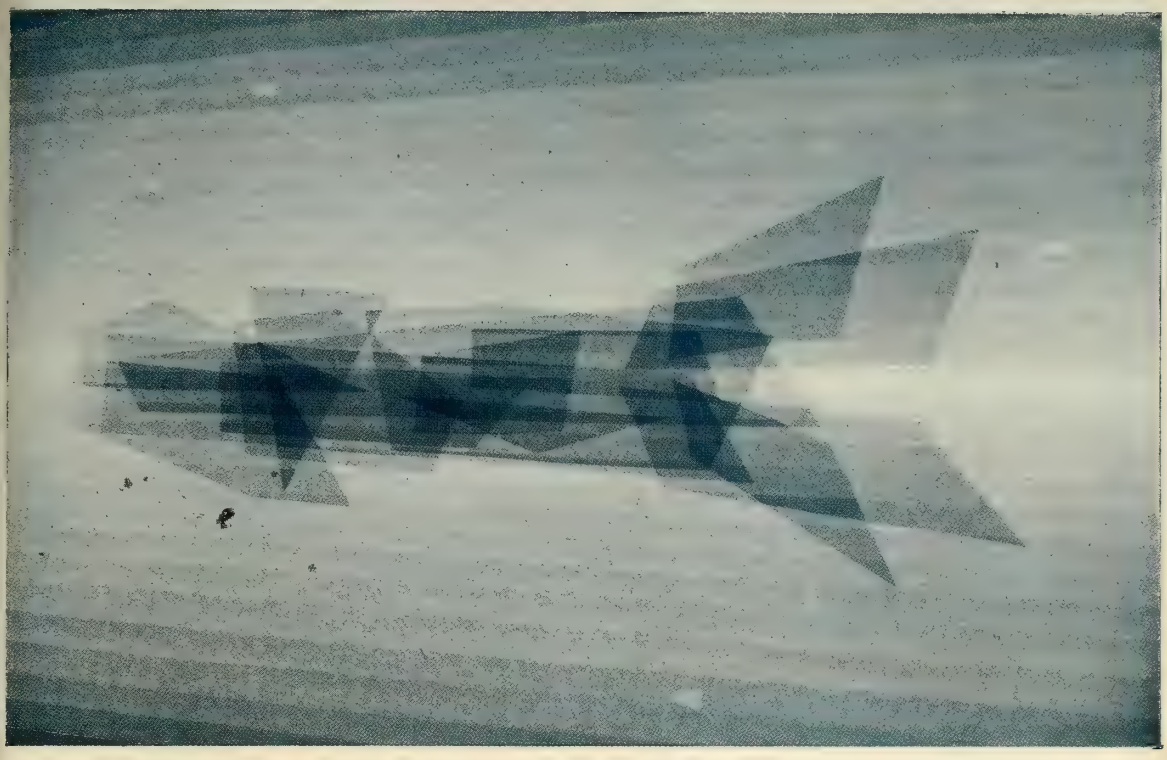
The entire system is comprised of three basic components: the camera; a remote control unit; and the plug-in amplifier for remote use.

The camera, without amplifier, weighs 35 lbs. including the film magazine, and measures 8¼ x 9¾ in. All camera controls, including full frame ground glass focusing, footage counter and plug-in switch unit, are designed for from-the-front operation. This enables the camera to be permanently installed in a corner. Two eye pieces, mounted on either side of the camera, serve as viewfinders and focusing lenses.

The plug-in control panel contains indicator lights to show when the unit is ready to run, focusing, or is running. Neither the "ready to run" nor "running" lights will come on, nor will the camera operate unless: (1) film is correctly threaded (2) film takeup is functioning properly (3) magazine is loaded (4) camera door is closed.

The remote camera control (DAR-10) permits camera operation from a distance of several miles. The same lighting system as in the plug-in control is used in connection with the camera's operational interlocks. This remote control-amplifier package weighs 7 lbs. with two channels. Available with up to 10 channels, the DAR-10 weighs approximately 3.5 lb. per channel.

When remote control is not required, the DAR-10 circuitry is duplicated by a multi-channel, transistorized "chin" amplifier that plugs into the front of the camera base. This unit measures 7 x 7½ x 7½ inches and weighs 7 pounds.



"ROCKETS", one of a series of paintings by Simpson-Middleman, a team of artists with the rare ability to translate scientific fact into creative imagery. Here, the rocket's blast and its guiding beam are thought of as a single stream of light through the center. Darks and lights of definite shape in a weak visual vector field are relied on to suggest the dynamics caused by the acts of the servo-mechanisms in making their adjustments. Painting courtesy John Heller Gallery, Inc.

man in space

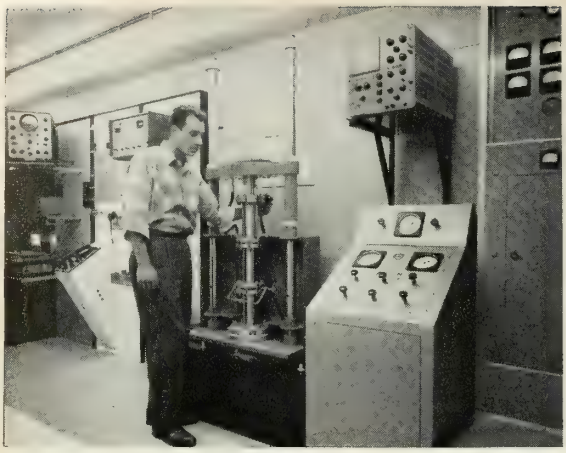
Boeing has planned ahead to meet the problems and develop the potentials of the space age—through organizational structure, expanded facilities and advanced fundamental research.

The Boeing Systems Management Office develops proposals and provides management for all projects employing space-age techniques. Advanced studies include boost-glide vehicles, anti-ballistic missile area defense systems, air-to-surface missiles, and manned and unmanned space vehicles.

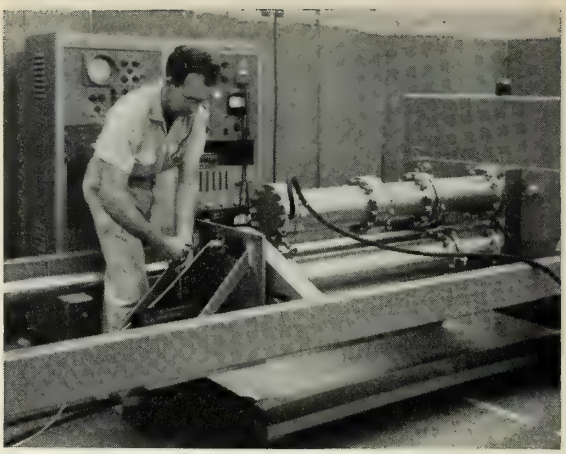
Boeing's space-age orientation, its tremendous technical and research capability, and its outstanding weapon system management experience earned for the company and its associates an Air Force assignment for Phase I development of Dyna-Soar. This is a weapon system based on a manned boost-glide vehicle that will orbit at speeds approaching 18,000 miles an hour, and be capable of re-entering the atmosphere and making a normal landing.

Dyna-Soar and other space-age projects at Boeing offer exceptional opportunities to engineers of all categories, and to physicists, mathematicians and scientists. Drop a note now to Mr. Stanley M. Little, Dept. **R-78,** Boeing Airplane Co., Seattle 24, Wash.

BOEING



HYGE SHOCK TESTER demonstration unit. The control cabinet is shown at right, Memo-Scope oscilloscope above.



CONSOLIDATED ELECTRODYNAMICS Hyge Shock Tester in use. Memo-Scope is panel-mounted behind operator.

Shock Tests Vital as Birds Get Bigger

by Raymond M. Nolan

WITH THE RECENT ANNOUNCEMENT that initial contracts had been let for *Minuteman,* (m/r July 28, p. 50) and with the *Polaris* well along in development, environmental testing phases of missile development assumed new importance.

Always a critical factor in testing, environmental factors will be much more stringent with the "second generation" solid-fuel missiles because of vastly increased shock, vibration and acceleration problems.

Probably the most important part of any test program is determining whether or not a missile can withstand the extreme shock, vibration, and temperature variations encountered during flight. The importance of this testing is due to the fact that there is no way to correct for environment-caused errors after the missile has been fired.

Shock is one of the many factors involved, and enters into the missile flight at several stages: firing, separation, firing of additional stages, buffeting of hypersonic travel. It is important to missile designers that the various components be shock-tested during development, and that these shock tests accurately simulate actual conditions for flight. Shock-tests will be even more important in the future, when big missiles will probably be all solid-fueled.

• **Hyge for shock**—At Lockheed's Missile Systems Division, the Hyge Shock Tester, now manufactured by Consolidated Electrodynamics' Rochester division under license to Convair, is used to simulate missile shock conditions. This compact instrument is capable of producing extremely high loads instantaneously, with precise waveform control. High-level thrust loads are transmitted to objects being tested by the instantaneous release of compressed gas acting against a piston.

A Hughes Memo-Scope Oscilloscope and two Consolidated Recording Oscillographs are used as readout and recording instruments. The Memo-Scope retains successive transients at high brightness until intentionally erased, thus permitting leisurely examination.

The Hyge Shock Tester is being used to great advantage on two research missiles—the X-7 and X-17.

According to R. C. Geiger of Lockheed's Missiles System Division, the Hyge is used for shock-testing missile systems and components to high acceleration values simulating booster firing and effection, parachute recovery, and ground landing impacts. The pulse shapes of these shocks are of such intensity and duration that they can cause malfunction or failure of sensitive tubes, relays, switches, gyros.

Even intermittent failures of these components can cause loss of control and destruction of hypersonic vehicles. It is absolutely necessary that all such components be tested completely before use to minimize the possibility of in-flight failures.

The Air Force has found the X-7 to be a thrifty device, since it may be recovered by parachute to fly again. Loaded with electronic gear, the X-7 sends a stream of continuous performance data to the ground by radio while it is in flight. Each re-flight of the needle-nosed missile saves taxpayers $350,000 in missile research costs.

The other Lockheed "test bird," the X-17, is a three-stage ballistic rocket weighing more than six tons and standing as high as a four-story building. Nevertheless, it is inexpensive as compared to full scale operational missiles. This rocket is used to provide information on problems arising when the warhead of a ballistic missile re-enters the earth's atmosphere at high speed.

• **Key links in defense program**—Because these Lockheed test missiles have been described by the Air Force as playing vital roles in the nation's missile development programs, great care has been exercised in securing the best equipment available.

The Hyge Shock Tester has already brought about an improvement in obtaining consistent test results, since shocks can be exactly repeated without the serious variations apparent in sand-box drop tables. The unit has provided a definite improvement in testing techniques.

Prior to installation of the Hyge, all shock testing was accomplished by one of two methods. For shock pulses of five milliseconds or less, a steel hammer with a cast lead nose was used to

strike a pendulum fixture on which the specimen was mounted. The shape and size of the lead nose was varied to obtain the pulse shape, and the height of swing of the hammer controlled the pulse amplitude. This method required replacing the lead slug after every shock.

• **Hyge gives precision**—With Hyge, the wave-shapes, time bases, and levels can be exactly calculated and predicted by means of the metering-pin contours. In many cases, a single metering pin can be used to perform acceleration tests at a wide range of "g" levels with considerable variation in specimen weights, by changing the unit firing pressures and fluid levels.

The output waveform of the acceleration pulse is fed directly from the accelerometer to the Memo-Scope for actual measurement.

To observe an acceleration pulse, a calibrated (Millivolt/G) accelerometer is attached with the test specimen on the Hyge-Shock Tester. With the accelerometer output then fed to the vertical input terminals of the Memo-Scope, and the scope input in millivolts on the screen of the tube, the vertical input of the occurrence will read in G's per square $\frac{(MV\ G\ )}{(SQ\ MV)}$.

The Memo-Scope horizontal input can be adjusted for sweep time to read milliseconds per square. Firing the Hyge will produce an acceleration-time waveform on the screen which can be read directly. The Memo-Scope tube will store the information for weeks, if necessary. However, a record picture can be taken of the screen for permanent file.

The Hyge Shock Tester has been used to simulate shocks of as high as 200 g's, and shocks of lower amplitude but with a duration of 35 milliseconds. Internal bore diameter is six inches, and rated output thrust is 42,000 lbs.

As it is set up at Lockheed, the Hyge installation includes a control console, actuator, and carriage rail system. The Hyge is mounted horizontally on a large concrete block. Force of the piston propels the carriage, which carries an air brake, along a rail system. Using the rail system to produce low levels of deceleration is advantageous in studying component failures, because the direction and magnitude of deceleration force can be controlled.

• **Oscillographs monitor circuits**—The two Consolidated Electrodynamics Recording Oscillographs, a 14-channel Type 5-116 and a 50-channel Type 5-119, are used to monitor circuits and components of systems under test.★

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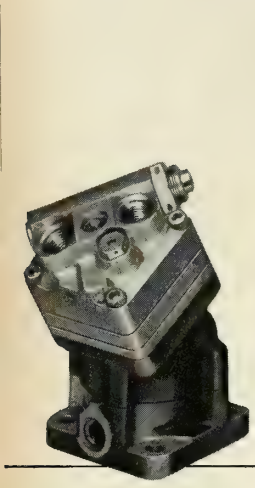
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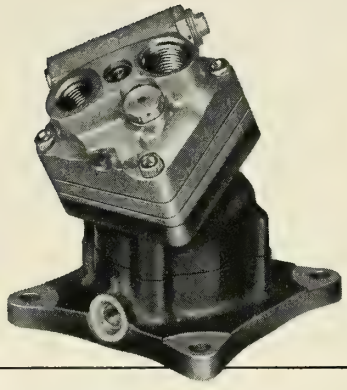
Design breakthrough no

VICKERS® ADVANCED DESIC

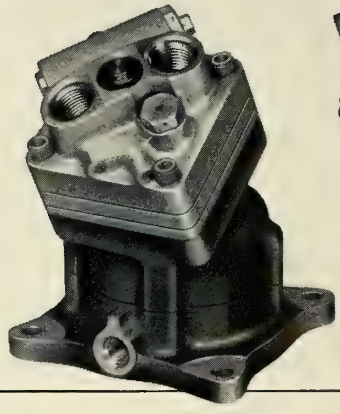
(PV SERIES)



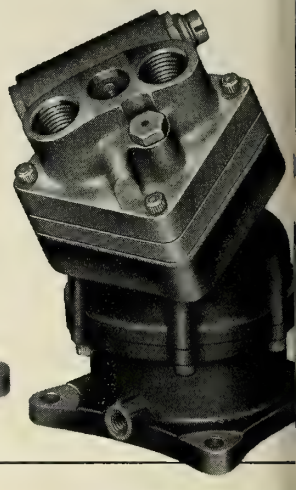
Model Series	PV006
Theoretical Dspl.	.095 cu in./rev
Rated Speed	12,500 rpm
Weight	2.4 lb
Hp/lb @ Rated Speed	3.8
Bolt Spacing	1.875″
Overall Length	4⅜″



Model Series	PV012
Theoretical Dspl.	.188 cu in./rev
Rated Speed	10,000 rpm
Weight	4.2 lb
Hp/lb @ Rated Speed	3.4
Bolt Spacing	3.536″
Overall Length	5 7/32″



Model Series	PV024
Theoretical Dspl.	.367 cu in./rev
Rated Speed	8,000 rpm
Weight	5.9 lb
Hp/lb @ Rated Speed	3.8
Bolt Spacing	3.536″
Overall Length	5⅞″



Model Series	PV0
Theoretical Dspl.	.600 cu in./r
Rated Speed	8,000 rp
Weight	9.5
Hp/lb @ Rated Speed	3
Bolt Spacing	3.53
Overall Length	6 13/

• "Design breakthrough" as used on this page is a carefully considered statement. Here is the lineup of the PV series fixed angle variable displacement hydraulic pumps for aircraft and missiles systems optimization. The numerous important improvements briefly discussed at the right indicate that these advanced design pumps are destined to set new standards of performance.

All series have integral automatic pressure compensator and a broad range of control methods. This advanced design requires substantially fewer parts than conventional design . . . and it has reduced to a minimum the number of external sealing elements. Now, for the first time, the power saving (and heat rejection) advantages of variable displacement are available in pumps of fixed displacement envelope and weight.

When first announced last March, only the smallest unit (Series PV006) had completed exhaustive endurance tests and was available. Now three more series (PV012, PV024 and PV039) are ready for system application. Three larger sizes are in the development stage. *For further information write for Bulletin A-5233.*

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IMPROVED LIFE

Exhaustive endurance tests have proved these new pumps meet the requirement of new MIL-P-19692 specification (i.e., 750 hours at rated rpm which is a very substantial increase over the 560 hours previously required).

INCREASED SPEED CAPABILITIES

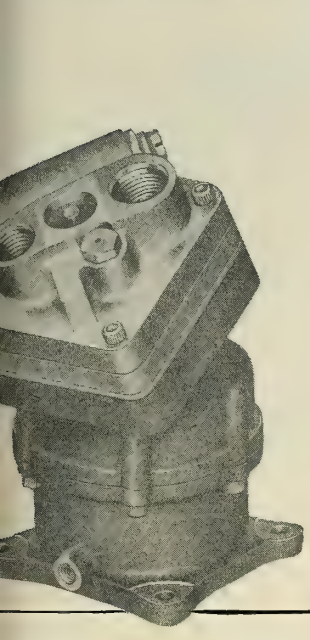
The maximum recommended speeds (both continuous and intermittent) have been greatly increased for all sizes without exception . . . more than doubled for some models.

SAME HIGH EFFICIENCY

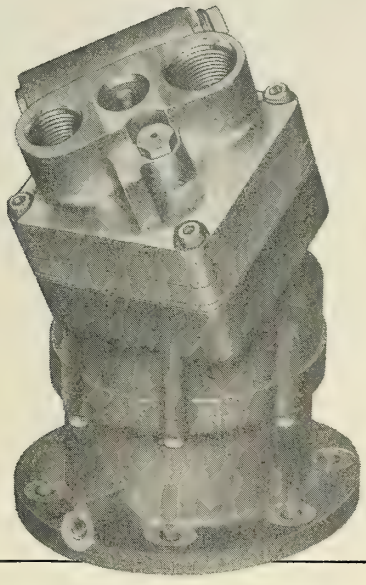
Volumetric efficiency is from 96% to 98% over a pressure range of 500 to 3000 psi. All the improvements enumerated here have been made without any sacrifice of the exceptionally high efficiency inherent in Vickers axial piston type pumps . . . under partial as well as full flow conditions.

depth!

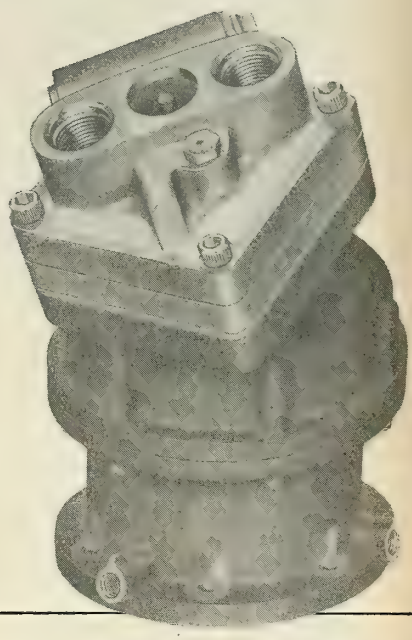
ARIABLE DISPLACEMENT PUMPS



Model Series.....PV062
Theoretical Dspl. .950 cu in./rev
*



Model Series.....PV104
Theoretical Dspl. 1.600 cu in./rev
*



Model Series.....PV153
Theoretical Dspl. 2.350 cu in./rev
*

Similar inherent performance advancements shown for the smaller pump sizes will be carried over to these models.

IMPROVED RESPONSE

The PV006 series is capable of full flow to zero flow response in 0.02 sec and zero flow to full flow response in 0.04 sec without pressure oscillation.

MINIMUM PACKAGE

These PV series variable displacement pumps have practically the same envelope as constant displacement units of equal output. In comparison with standard variable pumps, the reduction in envelope varies from 70% to 15% as size increases.

IMPROVED CONTAMINATION RESISTANCE

Performance of these new pumps is greatly improved even when operating with contaminated oil. This improved contamination tolerance results from changes in both design and materials.

IMPORTANT WEIGHT SAVING

The new advanced design pumps represent a 100% increase in power-to-weight ratio over any other variable displacement pumps now available. The magnitude of this improvement is evident from the fact that every added pound of component increases a missile's gross weight from 30 to 75 pounds.

IMPROVED RELIABILITY

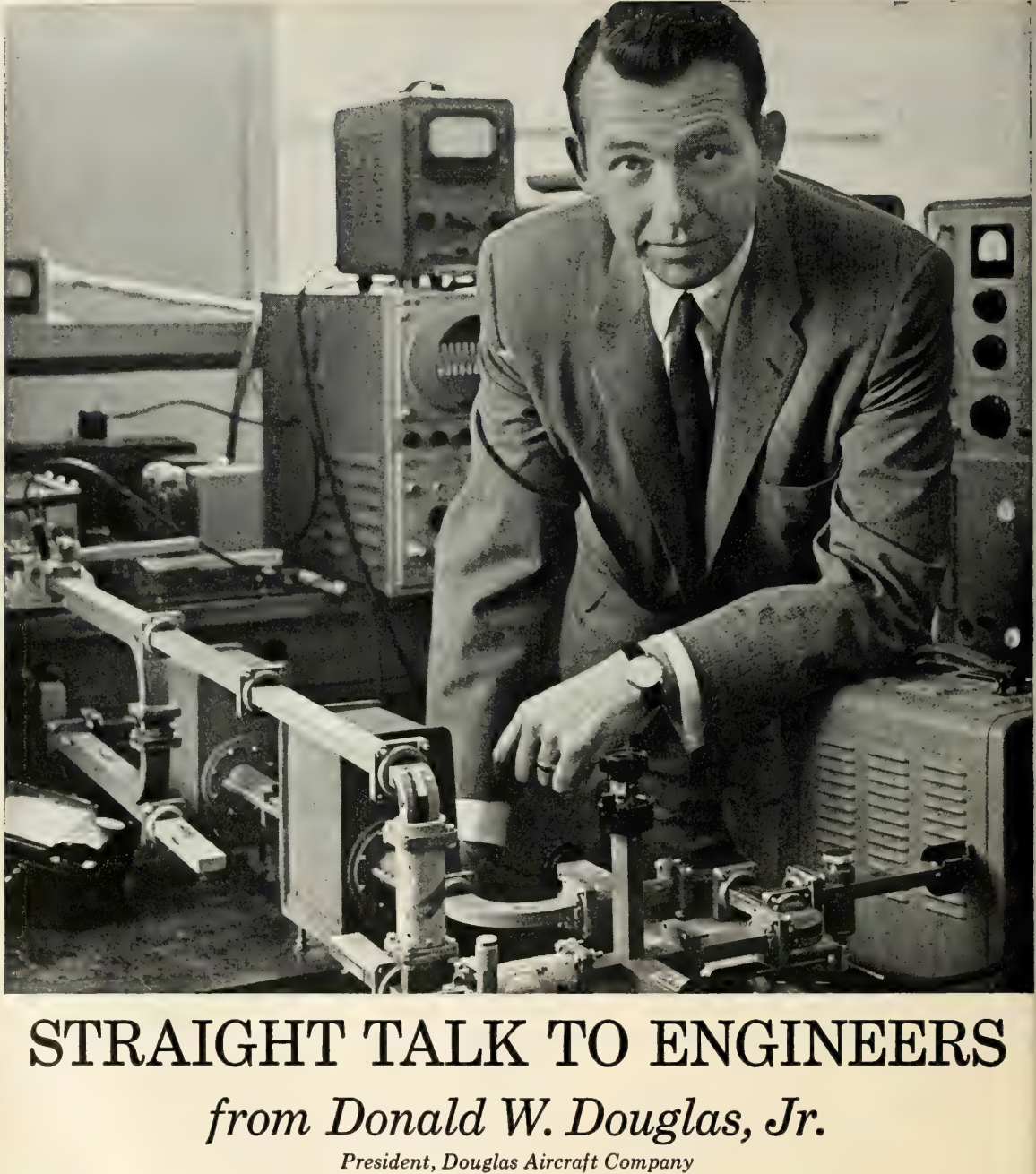
Exceptional capabilities (high speed, long life and contamination tolerance) under extreme conditions . . . even greater under normal application.

PARTS STANDARDIZATION

Major parts are interchangeable for fixed and variable displacement pumps and for fixed and variable motors in each series. This standardization results in customer savings.

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STRAIGHT TALK TO ENGINEERS

from Donald W. Douglas, Jr.

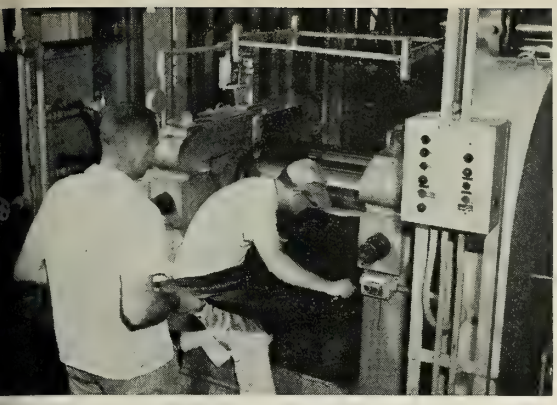
President, Douglas Aircraft Company

In your field, as most of you well know, it's easy to be complicated . . . it's hard to be simple. At Douglas, I'm happy to say, we do things the "hard" way. This matter of simplicity is vitally important. We work intensive hours, days and months to achieve it.

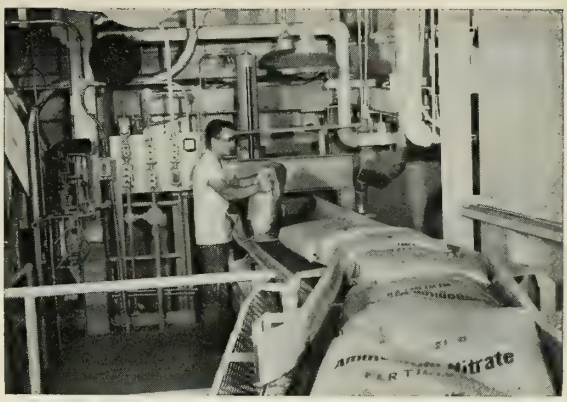
Why this extra effort? Well, simple things work easier, last longer, are more easily maintained and are lots more reliable. We are rewarded for our greater engineering effort with a product that performs better for our various customers.

We know that good engineers, working in an atmosphere which stimulates them to do their best, have been largely responsible for our success. If you enjoy solving challenging problems in the simplest manner, we'd like to talk with you about joining us.

Please write to Mr. C. C. LaVene
Douglas Aircraft Company, Box 620-R
Santa Monica, California



JATO manufacturing—Copolymer is first processed in Banbury mixer. Several lots of copolymer are intermixed to insure uniform viscosity and quality. Carbon black is added to upgrade the material and moisture is removed. Restrictor material is shown as it is pulled from roll mill. Sheets are rolled to thickness varying from 1/32 to 1/8 inch.



Fertilizer grade ammonium nitrate—used as oxidizer—arrives from line storage building by conveyor. Here bags are being opened for preliminary break-up of large lumps. Material will travel upstairs by skip hoist for start of crushing, drying, and grinding operations. Beyond this point, nitrate is processed by remote control in automatic equipment.

Astrodyne Shifts to Cast Grains

Newly-formed Corporation Enters Extensive Modification Program to Compete for Large-Grain Solids Market

by Norman L. Baker

McGregor, Tex.—Astrodyne, the most recently formed corporation in the field of solid propellant research, development and production, is adding to its R&D facilities in an effort to secure a strong competitive position in large cast rocket motors. First step in this direction was a complete reorganization program to assure maximum utilization of personnel and facilities.

The first test of the Astrodyne organization was made recently when the corporation submitted a proposal to the Air Force for research and development on the *Minuteman* ICBM weapon system. Although in the first go-around the Astrodyne proposal was turned down in favor of Aerojet and Thiokol, it has been voiced in some circles that they may be called in later for either R&D or production of the present *Minuteman* concept, or an advanced model of the system.

Astrodyne has more than five years of advanced research and manufacturing experience acquired when it was the Rocket Fuels Division of Phillips Petroleum. A major portion of the production experience has been in the field of small JATO units, with all extensive grain manufacturing using the extrusion process. This is where Astrodyne is currently directing its modification program.

The major difference between cast and extruded grain manufacturing is the final step operation where the grain is formed into its final shape. Propellant grains of the size needed for the *Polaris* and *Minuteman* missiles make it uneconomical and impractical to form them by the extrusion process. Large grain cross sections can be built up from smaller grains, but again this would be time consuming and impractical.

The first casting bell installation was recently completed at the McGregor 12,000 acre site, and construction is underway on new test firing cells. Astrodyne will devote increasing efforts on the development of continuous casting operations, utilizing a wide range of binders particularly suited to ballistic missile applications.

Contract awards have been relatively slow in coming to Astrodyne. Since its formation in February, the company has received $4-million in new research and developments contracts. The company plans to concentrate a major portion of its work in the next few months to research on high energy solids, missile controls and hardware, gas generator charges for auxiliary power units and boosters.

The current contract for production of 1000-lb. JATO units will end in February. The over 100,000-lb. thrust XM-34 booster recently shown boosting a F-100D fighter-bomber from a zero-length launcher is on a limited production schedule.

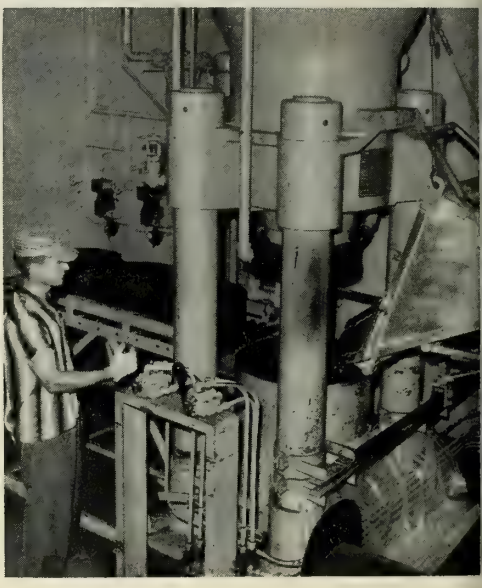
Astrodyne's main propellant and rocket development area includes: 1) a laboratory for conducting bench-scale experimentation on propellants and rockets, 2) an integrated pilot plant with equipment for performing all experimental grinding, blending, mixing, curing, and casting processes for motors of all sizes, and 3) research equipment for studies of new propellant formulations, preparation of solid propellant motors for development test purposes, and pilot manufacturing of new rocket motors and devices.

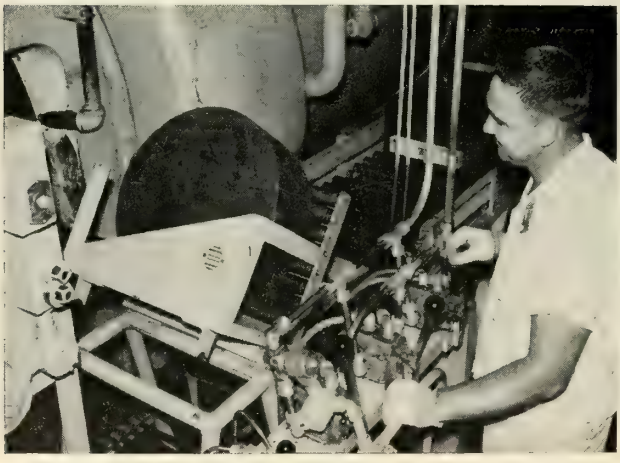
The McGregor production plant has turned out over 130,000 of the 1,000-lb. thrust JATO units. Scientists and engineers now at Astrodyne designed and developed the USAF JATO unit. The grains are made from low-cost, readily available ammonium nitrate—a commercial fertilizer. The cast propellant manufacturing process is almost identical. Major difference is in the mixing and forming stages. Following pages show process.



Completed ammonium nitrate propellant mix, looking much like soft coal, is scraped from mixer into cart for transporting to blocking press. Mix starts with a slurry paste of rubber and inert ingredients. Oxidizer is added in four equal parts during different stages of mixing. Total operation varies from 45 minutes to several hours.

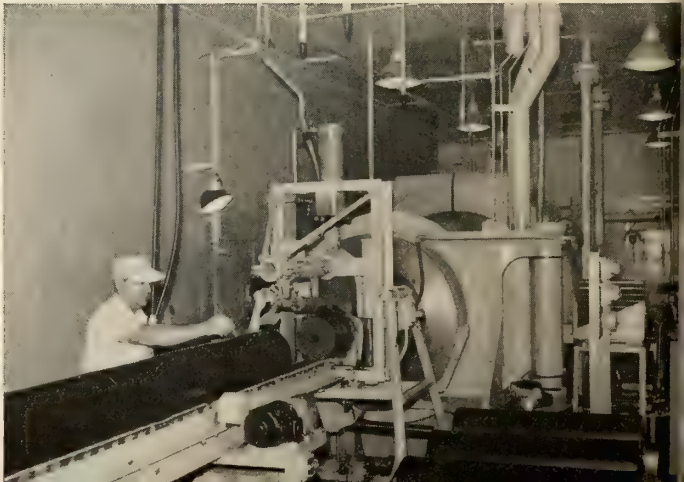
Freshly mixed propellant is carted from mixer and dumped into 490-ton blocking press. Press is operated by remote control after being loaded, automatically pulls a vacuum during early stages of press to eliminate air from propellant mixture. Blocks of propellant are numbered for identification.

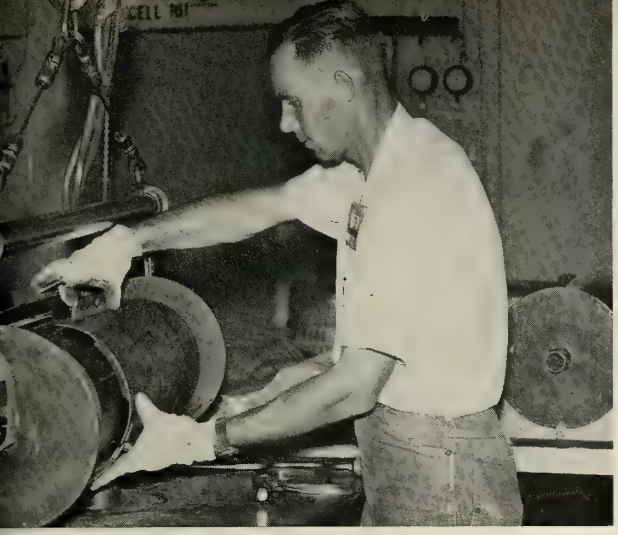




Block of propellant is charged to the extruder. After loading of three blocks, extruder is operated by remote control. Machine's barrel is made of chrome hardened steel. Aluminum face plate on ram prevents scratching and excessive friction heat; is coated with silicone grease to facilitate release of propellant from ram after extrusion.

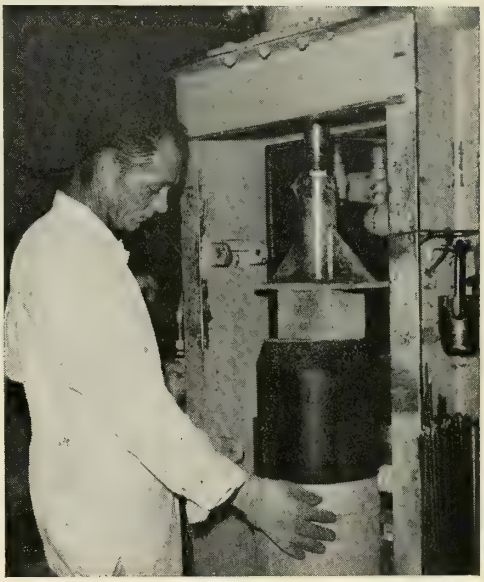
JATO grains emerge from 2,100-ton extrusion press, are numbered for quality control purposes. Press extrudes at rate of nine inches a minute; automatically rough cuts each grain to pre-set length. Astrodyne numbering system permits tracing history of any single JATO unit from the field all the way back to original lots of raw materials going into the mixing formulation.

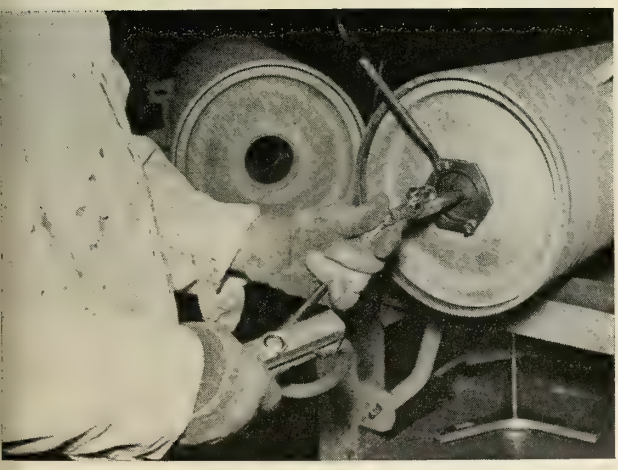




Operator applies combination of sponge pad and buring restrictor to the grain, clamps on metal corset to hold in place during 24-hour curing process. Automatic lathes have been used to bevel grain ends and trim to finished size. Mandrel with wheels is inserted in center core of grain to facilitate movement through curing oven.

JATO grain and metal case meet for first time at loading station. Here, close-fitting grain is forced into case under 3,500 pounds pressure. Machined steel head is positioned and locked with metal strip key. A rubber O-ring between head and case provides the necessary pressure seal.





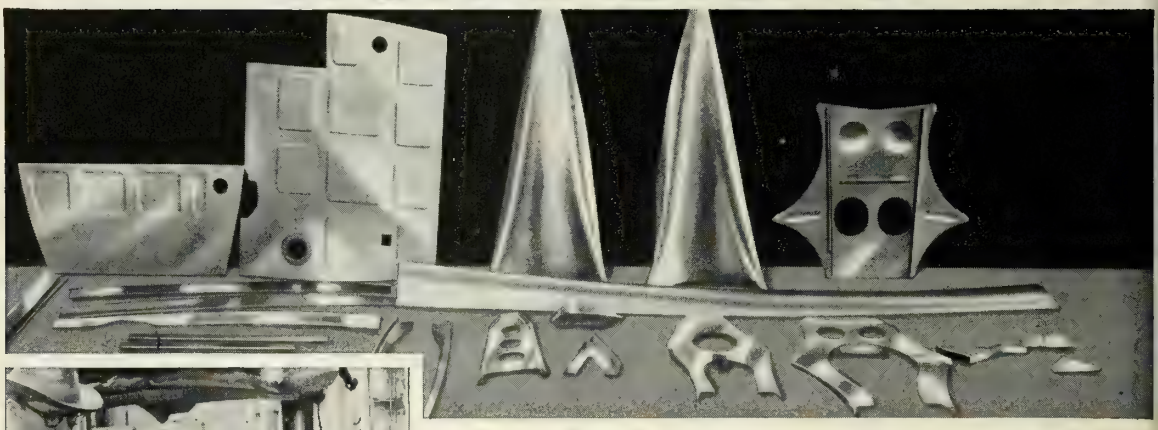
Nozzles are added and units are air tested under 10 pounds of pressure as final manufacturing step. Special shipping plug is installed in the igniter opening while the units are being transported to the field. Company name and identification markings are stenciled on case before it is loaded into shipping case.

Finished JATO's are loaded nine to a case for shipment to Air Force bases. A protective cap covers each nozzle and igniters are loaded separately in protective tubes inside the crate. Wooden crates are manufactured by a sub-contractor in McGregor, and are used to transport new JATO cases from a second sub-contractor to the plant.

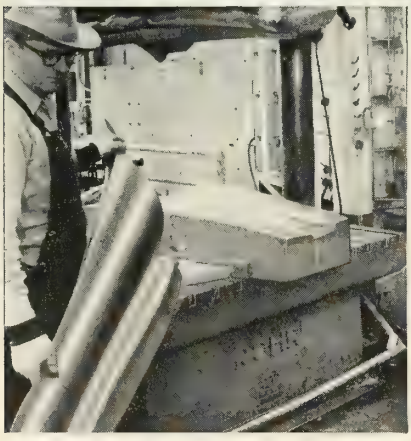


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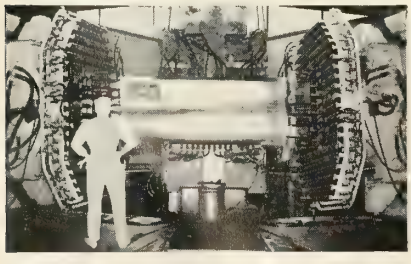


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Any doubt in your mind as to titanium's versatility and adaptability for forming and fabrication? Then check these examples from Rohr Aircraft Corporation, Chula Vista, California.

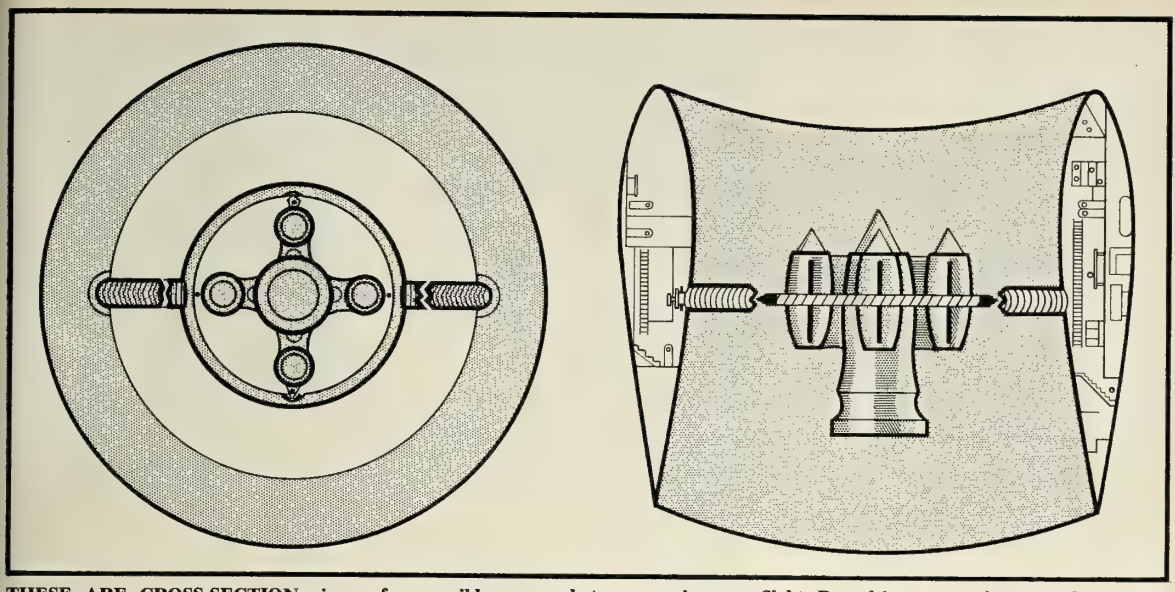
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THESE ARE CROSS-SECTION views of a possible approach to economic space flight. Propulsion system is centered and fully gimbaled and includes turbo-jets, ram jets, ion rockets and (for emergency) chemical rockets.

Why Not A Logical Approach to Space Flight?

by W. O. Davis*

THERE IS ANOTHER, vitally important approach to the problem of manned space flight. It is an approach that has been hidden by the pre-occupation of many scientists and engineers with ballistic missile principles.

The approach is Conceptual Design. The principle behind it is as old as engineering itself—visualize the problem first, then design a vehicle that will meet the needs.

For example, a manned mission into space might be divided into six phases; in order to determine what performance will be required of a vehicle, and what characteristics it must have in each of these phases. Logically, the trip could be divided into six parts: takeoff; climb phase below 15,000 ft.; climb phase from 150,000 ft. to orbital speed; cruising; descent and landing.

• **Take-off**—Objective is safe departure from the surface and transition to the climb phase. Essential to this is a highly reliable propulsion system and accurate control.

To insure safety and ease of control, the vehicle's aerodynamic features and propulsion system should be optimum for flight at low speeds and altitudes. Fuel consumption during the first phase should be minimized. The vehicle should not need a large or specially prepared take-off area. Acceleration should be gradual, and so should the change of direction.

• **Climb phase to 150,000 feet**—Safety remains an important, but secondary objective. As the altitude increases, the factors governing safety become more and more an environmental problem. The primary objective of this stage is to gain altitude.

The cost of gaining high speed in the denser portions of the atmosphere is high, and it is best to stay subsonic until entering the higher altitudes. Propulsion and aerodynamics must be optimized for this phase for the rapid acquisition of altitudes. As in take-off, fuel consumption should be held to a minimum.

From the point of view of human factors, acceleration should be kept moderate. As altitude increases, internal temperature and atmosphere must be carefully controlled, to minimize crew's discomfort.

• **Achievement of orbital speed**—At approximately 150,000 feet, air density is no longer a problem, and the primary objective is to obtain orbital speed. The ability to control minor motions becomes less urgent. The atmosphere should be used as a working fluid as long as possible to minimize take-off weight. Acceleration and radical changes in direction must still be kept moderate for crew safety.

• **Cruise**—The cruise phase involves flight completely outside of the earth's atmosphere. Now we want distance. And, the need to return to base with sufficient fuel lift for a successful landing. Space flight implies design which incorporates the lowest possible mass ratio. Safety is important, but at this phase it centers largely around the factors of human environment. Can we depend on our simulated internal atmosphere, radiation insulation, and can we avoid objects in space? Travelling great distances in space calls for a simple, reliable propulsion system. Great speed is required, thus a continuous low rate of acceleration is needed.

An optimum balance must be achieved between the amount of fuel carried to permit continuous acceleration and a short trip; or a high payload weight of stores to sustain the crew for a long period of time and a slower trip. It may prove desirable to accentuate fuel capacity and consumption to limit missions to days, rather than to fly trajectories which would extend the mission to months or years at minimum energy.

• **Return to earth**—The vehicle will initially follow an orbital track. The first element of the descent phase is to reduce speed to insure safe re-entry into the earth's atmosphere. Design criteria must include rapid heat

**Formerly Deputy Commander for Operations AFOSR, ARDC.*

dissipation and thermal protection for the crew. Control resumes its initial importance as the vehicle nears landing.

• **Landing**—An integral part of this objective is close directional control, low rates of deceleration, and the ability to land in a small, relatively unprepared area.

• **Design**—With these requirements in mind, the total design of the vehicle must incorporate economy of construction and operation. These factors, coupled with a reasonable payload, are essential if we are to perform useful military or commercial tasks. The ideal is a single configuration.

Assuming that certain technical capabilities have been achieved prior to construction, we might arrive at a design configuration similar to that depicted here (see drawing).

The annular air foil has a high strength-to-weight ratio and good aerodynamic qualities during take-off, landing, and both high and low speed flight. It is also well suited to central location of several different propulsion systems.

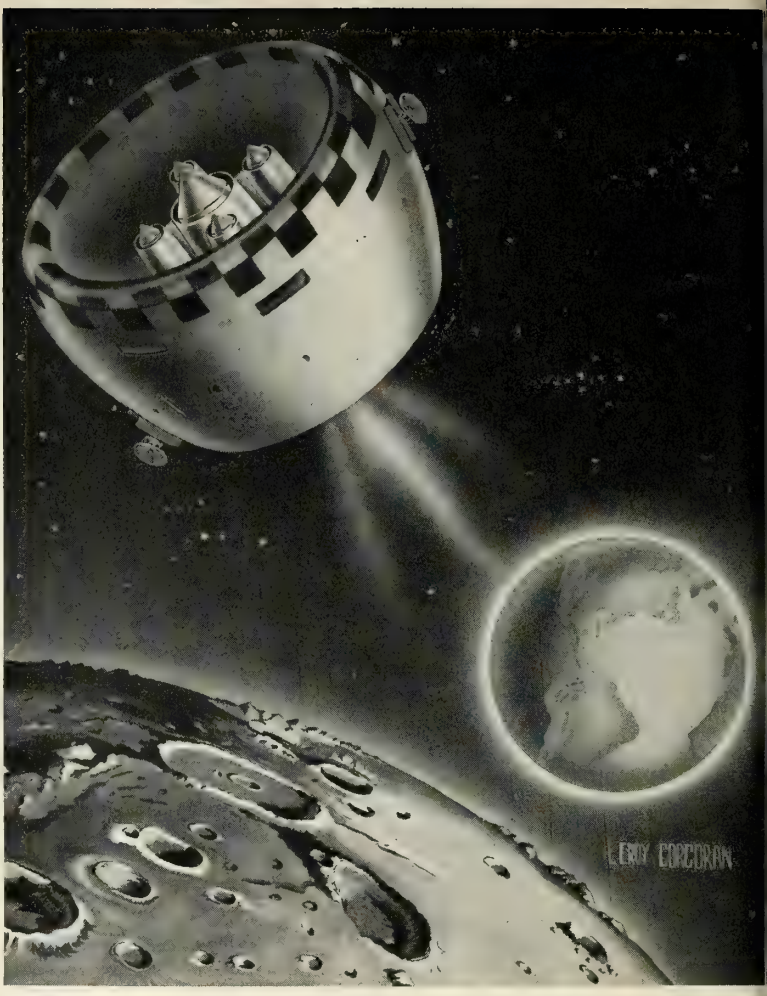
The large surrounding cylindrical area has exterior wall surface that can become a floor during the cruise phase of the trip. (At this point in the journey, it may be necessary to rotate the vehicle about its central axis in order to simulate gravity by use of centrifugal force.)

During the take-off phase, the vehicle would be propelled by large turbo-jet engines, operated by either chemical or nuclear heat. During take-off, solid propellant rockets might be added, as stand-by power in case of failure of one of the turbo-jets. In this event, control would presumably be provided by balancing the thrust of the remaining jet engines.

As the entire propulsion system is hung in gimbal mounts, control can be achieved by tilting the power plant or inverting it on its horizontal axis to provide reverse thrust for slow-down during the landing or re-entry phase.

• **Propulsion system**—The main propulsion unit might be a large ram-jet engine surrounded by the auxiliary turbo-jets. The ram-jet engine would have a nuclear heat input and would be activated as soon as optimum speed and altitude are reached. On attaining an altitude of 150,000 feet, some means of electromagnetically accelerating particles of ionized atmospheric constituents would gradually be introduced, thereby making use of the magneto-hydrodynamic properties of ionized gases.

As the flight progresses into the ionosphere and the density of the atmosphere decreases, the electromagnetic propulsion system will be of increasing importance.



A VIEW of Col. Davis' "conceptual design" as it might appear in flight past the moon. It is operating on its ion propulsion system, having first reached orbital velocity by means of turbo-jets and ramjets.

In this phase, despite the use of electromagnetic propulsion, acceleration of the vehicle will decrease. As orbital speed is achieved, however, the degree of acceleration becomes less important. At the top of the atmosphere density approaches zero, and it is necessary to introduce a source of ions into the propulsion system. For the first time, a working fluid will have to be used, though it may be supplemented to a small extent by ionized particles that occur naturally in space.

During the cruise, a combination of ion source and electromagnetic propulsion will provide a continuous but low acceleration, perhaps of the order of 1/1000 to 1/100 of an earth gravity. Rotation of the vehicle about its axis will be achieved by deflection of part of the exhaust stream, and artificial gravity achieved.

In the event that astronomical observation is required, the vehicle can be momentarily brought to rest and suitably stabilized. The ability to provide a constant but low factor of acceleration would permit a degree of maneuverability which will greatly simplify navigation.

• **Descent**—During the descent to earth, the electromagnetic propulsion system can be reversed and the kinetic energy of the vehicle converted into stored electricity, or dissipated as heat within controlled limits.

In this manner, the majority of the vehicle's kinetic energy should be dissipated before entering the lower layers of the atmosphere.

At an altitude where charged particles are no longer available, the ram jet can again become operational and, for the final landing, control can be gained by starting the turbo-jets.★

Soviets Discuss Satellite Crew Recovery

by Frank G. McGuire

A Stalin Prize winner, P. Isakov, has authored an article in the Soviet Army newspaper, RED STAR, on "The Problem of Returning Satellite Crews from the Cosmos."

Isakov has reduced the means of accomplishing the safe return of satellite crews to two possibilities: return of the satellite as an entire unit, and return of the crew only. According to the article, the second of these is the easier and most practicable method.

Ejection apparatus and hermetically-sealed capsules may be used for catapulting crews from rockets or satellites which have been slowed by use of retro rockets or braking ellipses. Isakov maintains that if the velocity of the satellite vehicle can be successfully lowered to the desired degree, the ejection of its crew can be accomplished by methods already in use in aviation.

The practical development of such a method, however, is still needed in obtaining supplementary data. Most important is the need to acquire sufficient temperature-rise data during different braking intensities, on cooling the satellite under different conditions, and other situations.

High-temperature effects on crew members is also being sought, according to the Soviet author, and the development of protective clothing and other equipment is a must. At present, he says, man is in a position to withstand surrounding temperature increases up to and over 100°C for short periods.

Clothing of special types has already been developed which permit a man to remain in a temperature of 300°C. He mentions, however, that this clothing was developed in "other countries" than the Soviet Union.

Acceleration and deceleration problems are also under study, Isakov says, and states that "it has been established that man can withstand a force of 3 — 5 g's for short periods with no harmful after effects." But he notes that continued acceleration or deceleration to this extent results in serious change in a man's condition which sharply limit his efficiency.

• **Italian experiments**—Isakov mentions the experiments of Italian scientists who subjected animals to g forces while the animals were submerged in water. Such a method, he notes, was suggested during Tsiolkovsky's time. The present experiments showed that under these conditions animals could withstand much higher g-loads than under normal conditions.

Excessive rotation was also listed by the author as a dangerous phenomena. Rapid and irregular rotation of the body in all planes can cause serious effects such as complete unconsciousness if a speed of 2-3 revolutions per second were experienced over a period of 10 to 15 seconds. In an ejected-capsule-type recovery of a crew from a manned satellite, this rotational factor would be a prime consideration unless a positive control on rotation were included in the equipment, as it undoubtedly would be.

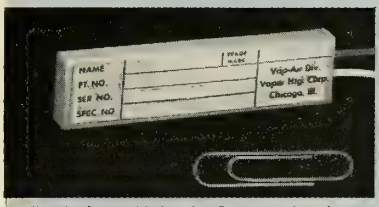
Live animals ejections from high-altitude rocket flights have been reported for some time by the Soviet Union, apparently in efforts to solve some of the problems covered by Isakov's article. Results of the experiments are reported to have been highly successful in proving that survival was indeed possible in extreme-altitude ejections, even though the vehicle was not travelling at orbital velocity.

• **Another technical article** in a Soviet magazine, by G. I. Pokrovsky, discusses the possible natural forces in

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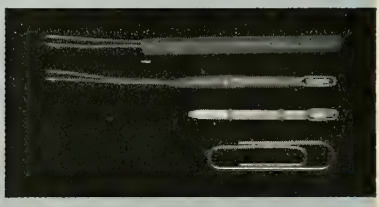
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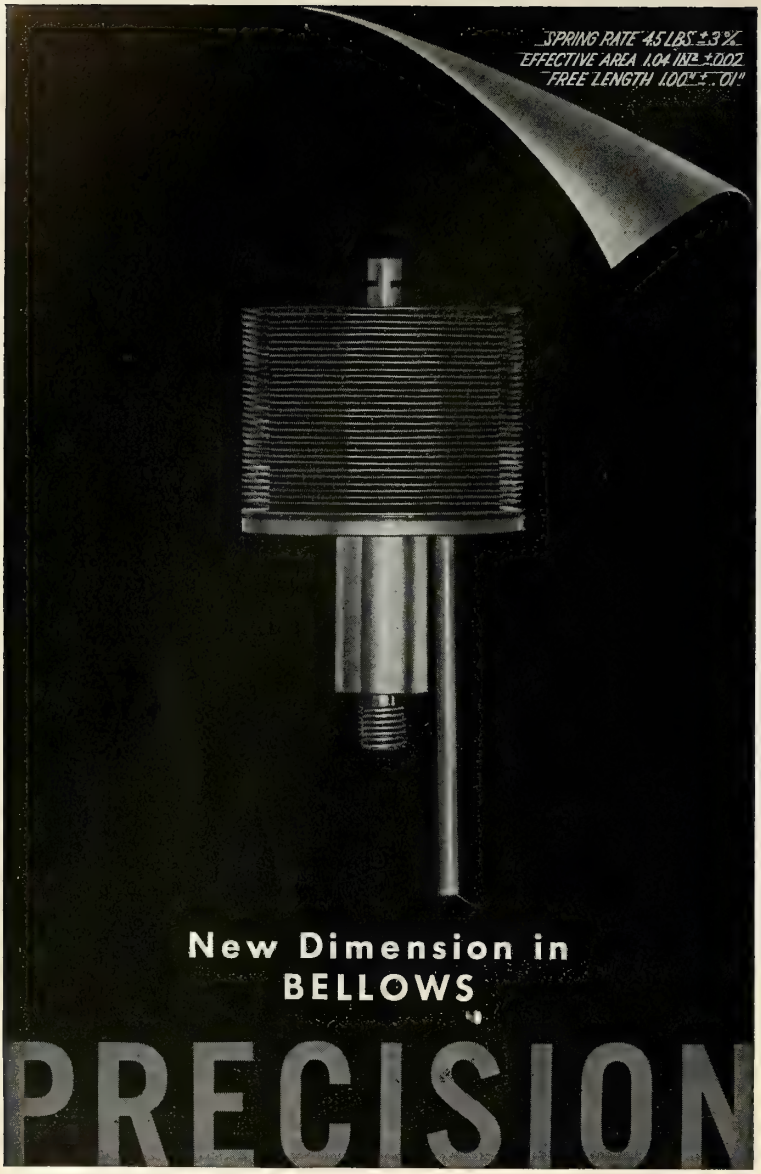
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. . . Soviet recovery

space which could be used to propel a space vehicle. The author of this article suggests that "cosmic electromagnetic fields" be used for controllable power. The author also states that the elements of the equipment needed to utilize this power have already been designed for other applications.

According to Pokrovsky, two particle accelerators comprise the basic element of this equipment. One is intended for the acceleration of positively-charged particle, hydrogen ions; the other is for the acceleration of the negatively-charged electrons.

If the first accelerator is in operation, a positive charge leaves the space ship and the whole ship is negatively charged. If the ship is located in a cosmic electric field, it will move toward the positive pole. Similarly, if the electron accelerator is operating, the ship will move toward the negative pole.

By changing the sign and magnitude of the charge, the cosmic ship can change acceleration and direction. Protons and electrons must be emitted from the ship at sufficient velocity to prevent their falling back on the ship.

The forces arising from this method will not be very large in most cases, Pokrovsky asserts, but considering the extent of outer space and the possibility of prolonged acceleration, one can imagine that electromagnetic fields in space can be utilized to great extent.

Varian Sales Reach All Time High

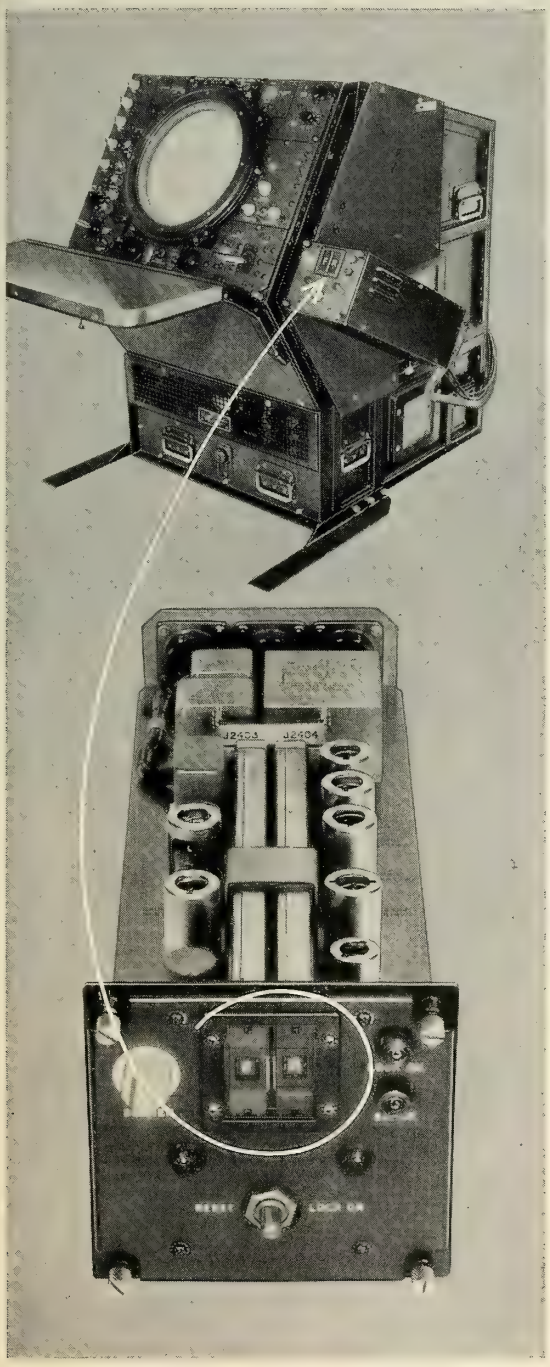
Sales of Varian Associates, Palo Alto, reached an all time high, according to the firm's third quarterly report to stockholders. Third quarter earnings per share are shown as 25¢, compared to 12¢ and 18¢ for the first and second quarters, bringing the electronics firm's nine months earnings to date to 55¢ a share.

In May, Dr. Louis Malter, who was chief engineer of the Semi-conductor and Material Division of RCA and formerly assistant director of their electronics research laboratory at Princeton, N.J., assumed the position of director of research for Varian.

Company-sponsored research and development is up 24% over last year, and the combined value of company sponsored programs and engineering effort carried out for customers was $3,815,653 for the first nine months of the year.

President H. Myrl Stearns stated that the company expects to maintain its present level of sales and earnings during the fourth quarter.

Union Indicators help Hazeltine radar-display unit identify aircraft



Just a glance at the little black box on the right side of this radar-display unit tells the operator whether an approaching aircraft is friend or foe. The IFF response is processed by radar equipment and is displayed in the Hazeltine unit by Alpha-Numerical Indicators manufactured by Union Switch & Signal. The radar-display unit is manufactured by Hazeltine Electronics Division of Hazeltine Corporation, Little Neck, New York. Hazeltine chose Union Switch & Signal's Alpha-Numerical Indicators because of their compact design and supreme reliability, and for the features listed below.

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Infinite Retentivity—Since the method of operation is of the null-seeking type, the Indicators require power only during the response time, and once positioned, retain the data both visually and electrically until such time as a new code is transmitted.

Electrical Read-Out—The design of the decoding and control portion of the Indicators inherently provides electrical read-out of data in the same form as the input. The data can be read out of the Indicators on a continuous basis or as often as desired without erasing the stored information.

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by Frederick C. Durant III

Two Japanese societies will be represented at the IX Congress of the International Astronautical Federation (IAF) at Amsterdam, August 25-30. JAS President Mitsuo Harada writes that Masatoshi Tomioka, a science editor of the YOMIURI SHIMBUN newspaper chain, has been appointed delegate for the Japan Astronautical Society (JAS). Tomioka is a director of the JAS. Since the JAS became an IAF member in 1955, your columnist has had the privilege of holding proxy and serving as the Japanese delegate at the annual congresses.

In addition to the JAS, which is devoted primarily to astronautics, the Japan Rocket Society (JRS) will apply for IAF membership this year. Dr. Hideo Itokawa, leader of the Japanese IGY rocket research, expects to personally present the JRS application at Amsterdam.

Back from a junket to Moscow, IAF President Andrew G. Haley brings the news that the 1959 IAF Congress will probably not be held in the U.S.S.R. IAF Vice-President, L. I. Sedov, has evidently run into a snag in obtaining official approval for the event. The alternate 1959 meeting place, put forward by The British Interplanetary Society, is London. A bid for Stockholm as site of the 1960 IAF Congress has been made by the Swedish Interplanetary Society.

Vol. I, no. 1 of ASTRONAUTIK, technical journal of the Svenska Interplanetariska Sälskapet (SIS), has just appeared. A 52-page, well printed publication, ASTRONAUTIK will serve to disseminate details of space flight to Swedish scientific and technical circles. A membership list recently received, reveals that the SIS now has more than 200 members, a high percentage of whom are professional engineers or scientists.

Because of frequent requests for names and addresses of foreign rocket and space flight societies, column readers may obtain a copy from: 35 Lowell Road, Concord, Mass. Many readers are interested in astronautical publications in foreign languages, and a friendly welcome is assured anyone visiting the home offices of IAF member organizations in the 21 countries represented. Those anticipating travel abroad should write in advance concerning probable date of visit.

Erich Dolezal, vice-president of the Oesterreiche Gesellschaft für Weltraumforschung, Vienna, has just completed a two-month tour of the U.S. Sponsored by the American Council on Education, engineer Dolezal visited major rocket facilities and astronomical observatories coast to coast. He is editor of an Austrian science journal.

R. Jastrow and S. I. Harris of Naval Research Lab have published the study results of the fall of *Sputnik* I rocket body (Alpha I). It will be recalled that last December, the U.S.S.R. Academy of Sciences made allegations that remnants of the rocket body had fallen in Alaska and the U.S. Northwest. The Jastrow and Harris paper, using calculations based upon U.S. and U.K. radar observations, concludes that the rocket fell in Outer Mongolia on December 1. Last known observation was made by the Royal Radar Establishment, Great Britain, at an altitude of only 71 miles.

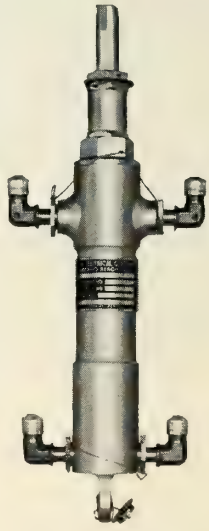
Three methods of tracking satellites have been used now: optical tracking, reception and triangulation of satellite-transmitted radio signals of various frequency, including the NRL minitrack system and radar reflection. The use of radar for tracking satellites was not planned by the U.S. because the size of the anticipated IGY satellite was too small. The Russian satellites, however, were above the threshold required to bounce back a receivable signal.

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books

METALS FOR SUPERSONIC AIRCRAFT AND MISSILES, The American Society for Metals, Cleveland, Ohio 423 pp., $7.50.

This is felt to be one of the most complete studies offered on the subject of metallurgical problems being encountered today.

Contents of the book include technical papers written by 22 authors and presented at the Conference on "Heat Tolerant Metals for Aerodynamic Applications" held last year. The conference was held under the joint sponsorship of the University of New Mexico, Albuquerque; and the Albuquerque and Los Alamos chapters of the American Society of Metals.

This study spotlights the phenomenon of the so-called "Thermal Thicket," wherein supersonic velocities result in increased temperatures of structures flying at those speeds.

NONLINEAR CONTROL SYSTEMS by Robert L. Cosgriff, 328 pp., $9, McGraw-Hill, New York

This book is another in McGraw-Hill's series on Control System Engineering. The book aims to provide the control engineer with those methods of nonlinear systems which are practical in the control field.

The selection of material is such that an extensive background is not required. Only those methods and techniques which are practical from an engineering standpoint have been included, and all mathematics beyond calculus is developed in the book.

Emphasis is placed on nonlinear theory and nonlinear equations. All important points are illustrated by examples, and the book includes a short, concise treatment of linear theory.

ELECTRONIC COMPUTERS, PRINCIPLES AND APPPLICATIONS, edited by T. E. Ivall, 167 pp, $10, Philosophical Library Inc., New York.

A compilation of articles which originally appeared in WIRELESS WORLD, this book is intended for familiarization with computers in general and, as such, stays away from too technical a presentation. Beginning with the evolution of computers and working through both analog and digital types, the book concludes with a chapter on computers of the future. While the material is not too technical, a certain amount of knowledge about electronics is a must.

The editor has chosen material which gives a reasonably broad picture of electronic computing.

when and where

AUGUST

AIEE, IRE, NBS Conference on Electronic Standards and Measurements, National Bureau of Standards Boulder Laboratories, Boulder, Colo., Aug. 13-15.

Industrial Applications of X-Ray Analysis, Seventh Annual Conference, Albany Hotel, Denver, Colo., Aug. 13-15.

Missiles Operations Research Engineering Seminar, Pennsylvania State University, University Park, Pa., Aug. 17-23.

AAS Annual Western Regional Meeting, Stanford University, Dinkelspeil Auditorium, Palo Alto, Calif., Aug. 18-19.

ASME, A.I. Ch.E. Conference, Northwestern University, Evanston, Ill., Aug. 18-21.

Second Symposium on Naval Hydrodynamics, Washington, D.C., Aug. 25-29.

Ninth Annual Congress, International Astronautical Federation, Amsterdam, Holland, Aug. 25-30.

SEPTEMBER

Summer Program, Problems of High-Powered Radar Design, Massachusetts Institute of Technology, Cambridge, Mass. (Security clearance required) Sept. 2-12.

1958 Cryogenic Engineering Conference, Massachusetts Institute of Technology, Cambridge, Mass., Sept. 3-5.

First International Congress of the Aeronautical Sciences, Palace Hotel, Madrid, Spain, Sept. 8-13.

American Rocket Society, Fall Meeting, Hotel Statler, Detroit, Mich., Sept. 15-18.

13th Annual Instrument Automation Conference, Convention Hall, Philadelphia, Pa., Sept. 15-19.

ASQC, 5th Annual San Francisco Bay Area Conference, Stanford University, Palo Alto, Calif., Sept. 19.

Professional Group on Telemetry and Remote Control, 1958 meeting, American Hotel, Bal Harbor, Miami Beach, Fla., Sept. 22-24.

Standards Engineers Society, Seventh Annual Meeting, Franklin Hotel, Philadelphia, Pa., Sept. 22-24.

Air Force Association, Airpower Showcase, Dallas, Texas, Sept. 25-28.

ASME Power Conference, Statler Hotel, Boston, Mass., Sept. 28-Oct. 1.

OCTOBER

IAS Canadian Aeronautical Institute joint meeting, Chateau Laurier, Ottawa, Oct. 7-8.

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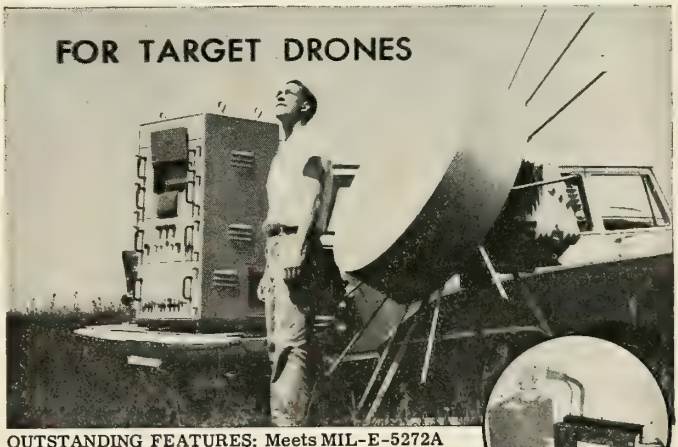
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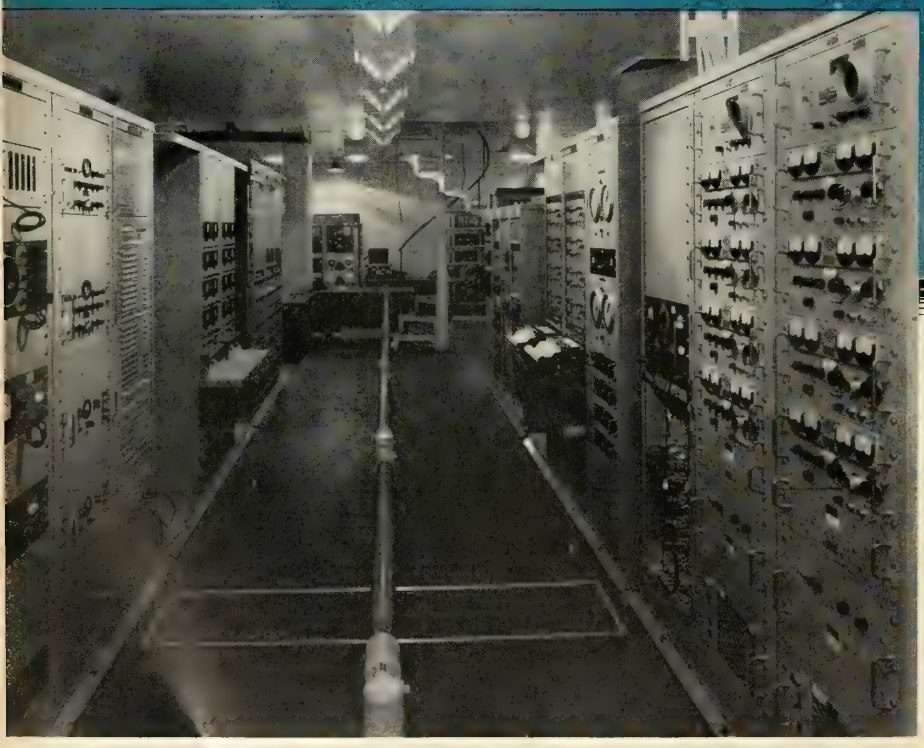
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keeping track

by Peer Fossen

Scientists here and abroad are drawing up plans to use radio signals to find an answer to the lunar dust problem. The plans involve bouncing a 20-cm wavelength, sharply beamed signal off the moon. Difference in attenuation between transmitted and returned signal will be used to determine existence and magnitude of dust layer. Main problem seems to be the establishment of standards for data reduction. If the theoretical analysis portion of the program can be solved by that time, the first transmissions will take place this fall.

Lincoln Laboratory, Mass., or N.R.L.'s facilities in Washington will handle the transmission. Location for the receiving terminal is Gothenburg, Sweden.

Goodyear Aircraft Co.'s Weapons System Division is currently beaming a lot of effort on a new guidance system for low altitude air-breathing missiles. The new system—named PINPOINT—will feature a mixture of ATRAN and inertial guidance. ATRAN, a map matching system developed by GAC for Martin's *Mace*, TM-76A, relates a film strip, actual or synthetic, to the terrain over which the vehicle is flying. PINPOINT will give more flexibility and accuracy.

Army has submitted a follow-up proposal to take 25 pictures or more of the moon, involving slight modifications of existing *Juno*-II hardware. This would be in addition to the two Army moon probes approved by ARPA.

Best possible photographic result from the earth is a resolution of one kilometer. Current plans for the first *Juno* II's are to take a picture at a distance of from 1,000 to 10,000 miles from the moon. Army would like to get a shot from as close as 300 miles, but doesn't trust its aiming accuracy that much. Land-type camera will take picture through long focal length (narrow angle) lens as it passes target, then develop and start transmission. Sending the picture back to earth may take hours, since limitation on weight and equipment necessitates slow scanning procedure and transmission over a narrow bandwidth.

The proposed follow-up probe would go around the moon, store the pictures, and then transmit them on the return trajectory.

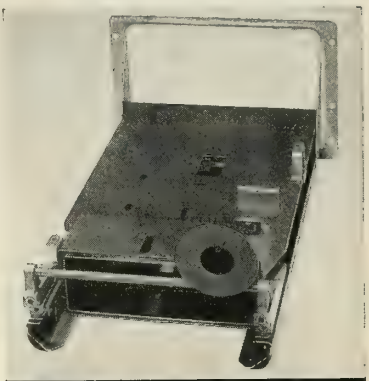
U.S.'s first prototype reconnaissance satellite may also include Land-type camera techniques. Land is currently working on the project with Jet Propulsion Laboratory.

Solar power units will not be included in the *Juno* II project. From a weight-space point of view, solar power is economical only when the power supply is required to be in operation for more than one week.

Released pictures of Sputnik III model indicate that the satellite is equipped with broad-band antennas. (See m/r, July 7, page 10.) Engineers in the telemetry game feel certain these antennas are used for facsimile or video transmission.

For those who are interested, the length of *Subroc* is 14 feet.

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ENGINEERING ES SERVICES



"SHOOTING" RED AND WHITE missile replicas with "haze" box attached to camera, as demonstrated by Raife Tarkington of Kodak Research Laboratories. The box arrangement enables simulation of atmospheric haze on the film.

Twinkling Stars Factor In Missile Photography

The atmospheric effect that makes stars twinkle is a factor in the latest work on missile photography at the Kodak Research Laboratories.

According to Raife G. Tarkington, chief of military photography at the laboratories, the studies have provided new information about the film characteristics needed to photograph far-ranging missiles.

Two factors affecting missile photography—the atmospheric conditions and the diminishing size of the bird as it recedes from the launching point—are reproduced to scale by the Kodak people. Atmospheric haze reduces the apparent contrast of the object, while atmospheric turbulence deteriorates the image formed by the optical system—the effect that makes stars twinkle.

To simulate these effects, a series of white- and red-painted missile replicas were fastened to a blue background. These replicas—which vary in size from ¼ inch to 2 feet—were then photographed under daylight conditions on several types of film, black and white as well as color.

Exposures were taken with each film using a simulated haze of 0, 25, 50, and 100% based upon the reflection of the white-painted missile.

Research has been performed with certain color films in detecting white-painted missiles. This is of great im-

portance in view of the fact that many missiles are rendered white by surface frost formation due to liquid fuel evaporation.

Tarkington said the tests demonstrated, above all, the importance of correct exposure of the film. With incorrect exposure, the smaller missile models are lost completely.

He declared that, in general, the effectiveness, resolving power, and sharpness of missile-tracking films are improved as the film sensitivity decreases. Therefore, the "slowest" film that can be exposed adequately in the system usually is chosen for missile photography.

Machine Computation To Be Discussed

Developments currently taking place in the fields of machine computation and data processing will be major subjects of discussion at the 5th annual Computer Applications Symposium, to be held in Chicago Oct. 29-30 at the Morrison Hotel.

The program for the first day will emphasize business and management applications; the Oct. 30 session will be devoted to engineering and scientific applications.

Topics scheduled for consideration at the business and management session include new concepts in large scale data processing, sharing a data processing facility by several organizations, and inventory and logistics problems.

The future of automatic programming, programming of learning techniques, and literature searching are among the topics to be discussed at the engineering and scientific applications session.

Fourteen speakers will participate in the two-day meeting.

Fred Gruenberger of Rand Corp. will be chairman of the business and management session, and Dr. C. B. Tompkins, professor of mathematics at the U. of California, L. A., will be chairman of the engineering and scientific applications session.

Semiconductors Feature Efficiency, Small Size

New silicon semiconductor devices are offering the computer industry more speed and efficiency and much smaller sizes than ever before, according to Dr. J. R. Madigan, vice president of engineering, Semiconductor Division of Hoffman Electronics.

"What we are achieving with silicon semiconductor devices," Dr. Madigan said, "is first, increasing the switching speed by the use of zener diodes, and

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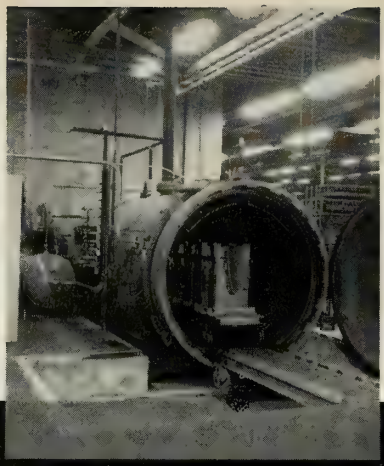
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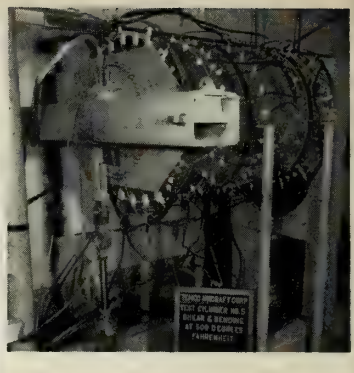
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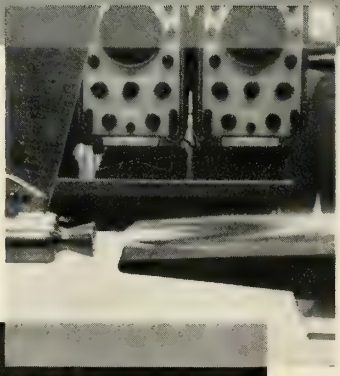






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At Temco metal and plastic sandwich structures have been employed in all types of airframe applications, with notable development in the field of stronger, higher heat-resistant metal bondings . . . in improved plastic materials and methods of reinforced plastic honeycomb fabrications.

Other outstanding advances now under development at Temco are a new low-cost process for brazing stainless steel honeycomb structures, employing a revolutionary new concept . . . and experimental progress in the new field of "cermets."

Since pioneering the "total package" concept of subcontracting . . . design, tooling and production . . . Temco's engineering staff and facilities have increased significantly, a growth as rapid and as sound as that of the industry they serve. Today these design support capabilities have been extended to encompass complete systems management. **Whether your need is for a component, a subassembly, or a subsystem, an inspection of Temco capabilities will prove profitable.**

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second, simplifying and speeding up readouts by our developments in photovoltaic silicon cells.

"These zener diodes are replacing slower switching devices formerly used in computers," Dr. Madigan pointed out, "and along with silicon photovoltaic cells, make it possible for computers and electronic control devices to respond more quickly and be smaller and more efficient."

He added that the new devices are more rugged and can be used in end-product computers and control units. "They have a tremendous advantage by the very nature of their construction," he concluded. "Environmental factors do not enter into their operational characteristics."

Solid-State Commutator Features High Accuracy

An electronic commutator for telemetering applications, with high accuracy over a wide range of mixed source impedances, has been developed by the Applied Science Corporation of Princeton Junction, New Jersey (ASCOP).

The new solid state multichannel sampling switch has an input-to-output accuracy of 1% or better for any mixed source impedances up to 25k ohms. This accuracy figure includes linearity and offset factors.

In addition, the new ASCOP electronic commutator develops a back current of less than 1 microampere during the time a channel is "off". This negligible back current completely eliminates the problem of transducer "loading."

Both the accuracy and non-loading features have been engineered as inherent parts of the ring counter-actuated diode gating circuitry, which forms the heart of the new commutator.

The electronic commutator is designed for long-life applications in data handling systems using time-division multiplexing. The commutator will handle 0 to 5V input signals in all I.R.I.G. standard Pulse Amplitude (PAM) and Pulse Duration (PDM) sampling rates. Standard channel configurations are 30 and 45, including synchronization pulses. A choice of combinations is possible.

The electronic commutator retains all the conventional advantages of solid state switching. Power consumption is something less than 3 watts. Design life expectancy is 5,000 hours without maintenance. Operating temperature range is −60°C to +80°C with special packaging available for extreme intermittent temperatures. The commutator's size is approximately 45 cubic inches, and the weight is approximately 32 ounces.

Missile Conference To Be Held in Chicago, Oct. 16-17

Testing long-range missiles will be described by one of the nation's leading authorities at the 14th annual National Conference on Industrial Hydraulics, to be held at the Hotel Sherman in Chicago on Oct. 16 and 17.

Maj. Gen. Donald N. Yates, commander of the missile test center at Patrick Air Force Base, Fla., will discuss this phase of the nation's missile development program before some 600 hydraulic engineers and industrial representatives at the opening session of the conference.

The subject of his address will be "Problems and Progress in Testing Long Range Missiles."

Another speaker at the opening session will be Kurt Stehling of the Naval Research Laboratory at Washington. Stehling is head of Propulsion Project *Vanguard*.

Ten technical sessions will complete the two-day meeting, which is sponsored by Illinois Institute of Tech-



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nology and its affiliate, Armour Research Foundation, in cooperation with several engineering societies and more than 100 industrial organizations.

The program will include 23 papers dealing with latest developments in industrial hydraulics, both fundamental and applied.

Sessions will be devoted to hydraulic applications in the aircraft and automotive industries, hydraulic fluids, presses, components and accessories, pneumatics, pumps, automatic machine tools, mobile equipment, and servomechanisms and systems.

Director of the conference is Ralph J. King of the research division of Caterpillar Tractor Co., Peoria, Ill.

New Magnetic Tape Available for Computers

A radical new "sandwich construction" magnetic tape for computer and instrumentation use that eliminates oxide rub-off, extends equipment life, and outwears conventional instrumentation tapes by 10 times or more has been announced by Minnesota Mining and Manufacturing Co.

Secret of the new tape is a thin, low-friction, plastic layer over the magnetic coating which prevents the oxide from contacting the recording head at any time, thereby eliminating all wear on the oxide itself.

Yet because the plastic layer—purple in color—is only 50 micro-inches thick, critical head-to-tape contact is sufficiently intimate for all instrumentation recording applications, except those where extremely high frequency response is required.

By eliminating oxide rub-off, the new sandwich tape provides greater reliability and freedom from signal error—especially critical in digital computer applications.

This is because the exposed oxide on conventional instrumentation tapes gradually wears off under repeated use, and the powdered oxide collects on the recording head as well as on the surface of the tape itself. Either condition may cause signal error.

The 3M Company reported that field tests have shown that the sandwich tape will last at least 10 times longer than standard tapes, and in many applications, has a usable life ranging from 30 to 100 times as long, depending on the recording system.

In a computer installation where exposed oxide tapes were usable for only 250 plays, use of the new tape has raised the figure to more than 11,000 plays.

Magnetic properties of the sandwich construction tape differ from conventional instrumentation tapes only in that the 50 micro-inch head-to-tape separation reduces signal level approximately 6 db at 1 mil wavelength. Medium and long wavelength responses are essentially unaffected.

An important feature of the new sandwich tape is freedom from drop-outs—minute flaws in the coating causing a momentary loss of signal. The manufacturer stated that the new tape contains not more than a single drop-out per roll (based on recording seven tracks on rolls ½" by 2500' long).

Dropout count is measured by inch on a 0.035" track. A reduction to recording 200 non-return pulses per less than 50% normal signal amplitude constitutes a signal error or dropout. Zero errors are measured by saturating the tape unidirectionally. Each spurious signal greater than 10% of normal signal amplitude constitutes a zero error.

Equally important, possibility of dropouts caused by oxide rub-off during subsequent use is almost completely eliminated, the 3M Company pointed out.

Radio Transmission Tests Use Moon As Relay Station

Radio transmission tests using the moon as a passive relay station have been conducted recently by the Signal Communications Department of the U.S. Army Electronic Proving Ground and Collins Radio Co.

According to Collins, these tests probably represent the first time that intelligence, in this case radio-teletype, has been transmitted in the ultra-high frequency region of 1,000 megacycles over the 500,000-mile distance from the earth to the moon and back.

Transmitting station for the tests was located near Fort Huachuca, Arizona, and the receiver was at Encino, New Mexico. The frequency of 810 megacycles per second was utilized in order to increase the effectiveness of the antenna systems, and to take advantage of lower signal losses in the transmission path.

During November, 1952, Collins and the National Bureau of Standards used the moon as a reflector to relay radio-teletype signals from Cedar Rapids to Sterling, Va. In these tests, an ultra-high frequency of 418 megacycles was used.

According to project personnel at Fort Huachuca, this type of communication is limited in range only by the ability to observe the moon simultaneously from both the transmitting and

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receiving points. Some appreciation of the distance involved in this method of communication can be obtained from the fact that a signal, traveling at approximately 186,000 miles per second, requires only 2½ seconds to travel the path from the transmitter to the moon, and back to the receiver.

If an artificial satellite can be utilized for this method of communication, the time of transmission and losses can be drastically reduced.

Tiny Radio Aids Guidance Of Missile to Target

A midget radio station, located in the nose of a guided missile, now helps to map its flight through space.

Developed and designed by IT&T Labs for Sandia Corporation of Albuquerque, N.M., the device can plot a missile's trajectory to within two yards of the target at a distance of 30 miles.

The equipment includes a transmitter on the ground linked to three receivers paralleling the projectile's route. By measuring to 10-billionths of a second, the elapsed time of a signal from ground transmitter to missile and back again to the three ground receivers, it is possible to compute and plot the entire trajectory of the missile from launching to impact.

The airborne transmitter, occupying only 50 cubic inches of space, "had to have perfect frequency phase stability over a wide range of temperature, vibration and shock," according to Albert E. Cookson, director of the ITT Laboratories' missile guidance section.

"As in most missile instrumentation units," he added, "it was desirable that it weigh nothing, occupy no space, draw zero power from the missile, and operate without antennas."

Ramo-Wooldridge Corp. to Transfer R&D Operations

Ramo-Wooldridge Corp. has announced plans to transfer its Advance Electronic Research and Development operations to a 90-acre site to be purchased in the western section of the San Fernando Valley. Construction will begin as soon as the Los Angeles Planning Department grants a conditional-use zone to permit construction.

First units of the new center will provide space for some 2000 scientists, engineers and administrative personnel. The Space Technology Laboratories, R-W's autonomous division, will take over the present R&D center at 5500 W. El Segundo Blvd. when the San Fernando buildings are completed.



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Circle No. 34 on Subscriber Service Card.

Signal Generators Uses Plug-In R-F Oscillators

Extreme versatility is offered by a new signal generator series comprised of a basic power supply and interchangeable radio-frequency oscillators developed by BJ Electronics, Borg-Warner Corp. Five plug-in oscillator units provide coverage of 20-80 mc, 300-500 mc, 800-1100 mc, 1100-1600 mc and 2700-3000 mc frequency ranges. Two types of modulator units offer the option of high or low power operation in the 500-1000 mc range. Individual design complexity varies according to stipulated frequency range and power level.

In high level operation, the Model 82 Signal Generator Series may be employed as a pole beacon for missile checkout equipment or for general laboratory measurements. In consideration of field use, design and fabrication is rugged and the series substantially immune to adverse environmental effects.

The basic power supply chassis contains 1000-2000 vdc continuously variable high power, and low voltage power supply; a variable-amplitude (1 kc) sine-wave oscillator and square-wave shaper. Provisions are incorporated for front panel indication and control of modulation and power level with an integral blower system to facilitate equipment cooling. The basic 19″ x $10\frac{7}{16}$″ x 16 x 18″ chassis weighs 59 lbs.

Individual plug-in r-f oscillator units contain the remainder of the generator components. According to the manufacturer, the r-f output is substantially constant over the frequency range, with low internal leakage. Front panel control adjustment sets the desired frequency. Accuracy to ±0.5% and frequency stability ±0.1% are stated operating features. Individual weights of the $6\frac{1}{16}$″ x $10\frac{7}{16}$″ x 17″ plug-in units vary from 17 to 20 lbs.

Circle No. 225 on Subscribers Service Card.

Production of Motorola Transistors Announced

Pilot line production of two new Motorola Mesa transistors has been announced. One is an ultra-high frequency amplifier capable of oscillating about 750 megacycles and accepting power gains of 12 D.B. at 200 megacycles. It operates above 100°C.

The device will withstand 50,000 G's of acceleration and will meet or



exceed all existing military specifications for shock, vibration and hermetic sealing.

The other development is a high speed switching transistor designated by No. 2N695. Switching time in saturating circuits is in the order of 10 milli-microseconds, and in non-saturating circuits from 1 to 2 milli microseconds. Typical saturation voltage is 0.25 volts, and the typical grounded emitter current gain is 30.

Circle No. 226 on Subscriber Service Card.

Miniature 16-Watt Servo Amplifier Available

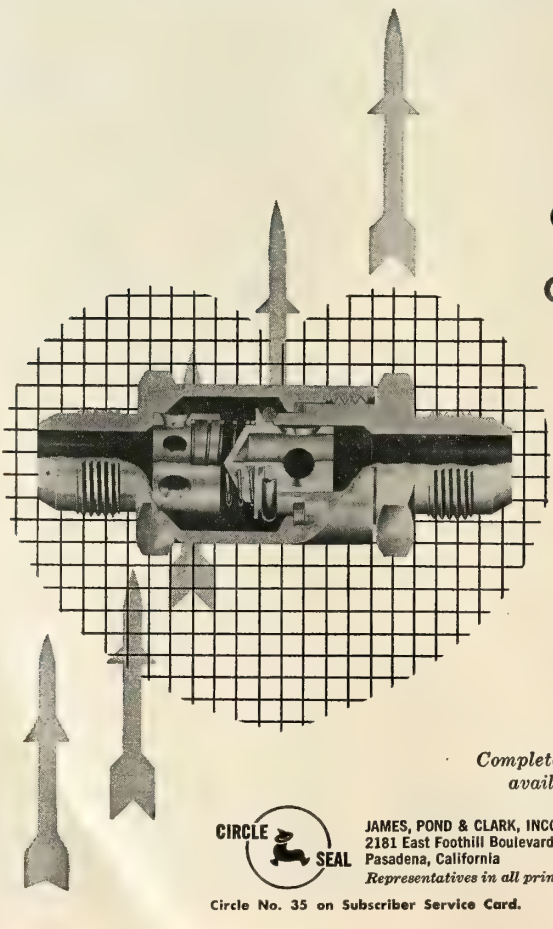
Kearfott Co. Inc. has introduced an addition to its line of servo amplifiers. Designed to deliver control phase power to 400 cycle servo components



requiring up to 16 watts of input power, this unit consists of an output push-pull stage, a driver push-pull stage a phase splitting stage, and a voltage amplifier stage.

A plug-in type component, this amplifier is completely potted in a compound having such high shock absorbent properties that four times the "g" value of maximum impact specified by the appropriate military environmental testing specification is easily sustained.

Voltage gain of the amplifier i



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subminiaturized servo program computer



Analog computers, advanced chemical and physics test equipment spell out the dimensions of the Edison Research Laboratory—one of the finest facilities of its type anywhere.

Edison's new servo program computer for an advanced—and classified—missile system sets new standards in lightness and compactness. Built entirely with Edison-manufactured components, this new unit weighs only 14 ounces, occupies only 14 cubic inches.

Within this size and weight Edison has created a complete servo computer package —containing transistorized and magnetic amplifier circuitry, servo-motor, precision gear train, two resolvers in a complete servo loop. The whole unit is hermetically sealed and highly resistant to corrosion and vibration.

Offering an optimum in response and sensitivity, this system shows the way to a wide variety of applications in missile control duties. It exemplifies the Edison capability in missile system design and manufacturing.

Because the Edison organization includes development and production facilities for servos, servo systems, magnetic amplifiers, computers, transducers, precision gear trains and miniature relays, Edison can become the *single source* for major electronic system assignments . . . can speed up prototype development faster than any other company. The Edison team concept in engineering, and unexcelled research laboratories for its scientists —are the other basic ingredients for success in advanced electronics projects.

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adjustable between 100 and 2,000 for a 40 volt load, and between 300 and 6,000 for a 115 volt load. The gain desired is obtained by employment of an external resistor, and when driving a 115 volt load, an impedance-matching output transformer is used in conjunction with the amplifier.

Measuring 2½"x2 3/8"x2¼", the A3104 transistorized servo amplifier is a versatile component, particularly in missile applications. The unit may be mounted in any position by means of captive screws which are available in various lengths to suit the user's application or particular need.

Circle No. 227 on Subscribers Service Card.

Tri-Axial Accelerometers Aid in Vibration Test

A new tri-axial accelerometer aids in conforming with the new vibration specifications for simultaneous measurement in three axes.

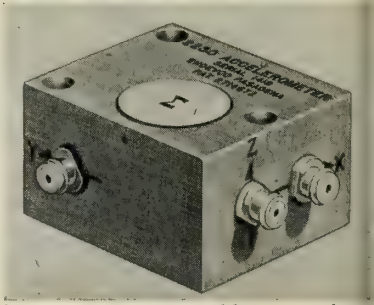
Three sensing elements are mounted in mutually perpendicular planes within a small compact block measuring 0.75"x1.25"x1.31".

Endevco Corp's. model 2243 (below) is designed to operate over a temperature range from −100°F to



+500°F, with maximum change of 10% in sensitivity, while model 2230 (below) operates accurately over the normal temperature range of 63°F to +200°F.

Both units have natural frequencies of 25 KC or more to assure wide flat



frequency response without spurious resonance. Sensitivities are 5 to 9 millivolts per g. A three point mounting is used to guarantee secure mating to test surface and proper orientation. Both accelerometer cases are electrically isolated from stray ground loops in the test structure.

Circle No. 228 on Subscriber Service Card.

Copper Shield and Jacket In Single Operation Possible

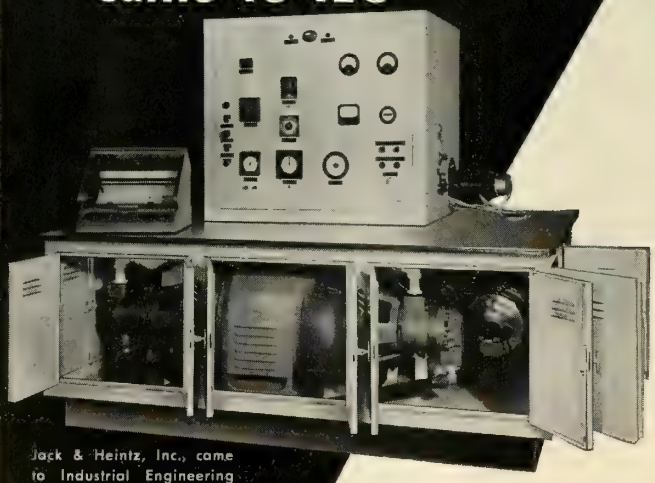
A copper shielding method which supplies a copper shield and a jacket



for wires and cables in a single operation is a new development of the Zippertubing Company.

Copper shielded zipper tubing is closed by a plastic or metal zipper track and, thus, easily may be zipped around wires and cables, giving 100% coverage. Great labor and equipment savings

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IF your problem is functional test equipment or control panels, Industrial Engineering Corporation can supply the answer. Whether your needs call for the use of hydraulic, pneumatic, electric or electronic principles—singly or in any combination — IEC has the imagination, the ability, the facilities to handle the job *right*, from original design to actual installation.

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are possible, as one man can close approximately 20 feet of zipper tubing per minute, while an expensive braider will shield a maximum of 1,500 feet per day.

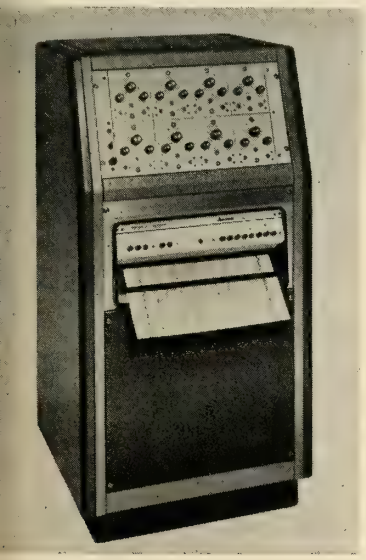
Shielded zipper tubing is available in inside diameters from 3/8″ up in increments of 1/8″. Standard color is gray, and standard put-ups are 25′, 50′, 100′ and 300′.

Circle No. 229 on Subscriber Service Card.

8-Channel Recorder Now Being Marketed

A new, 8-channel ultralinear recording system, Model RD 1684 00, with rectilinear readout and thermal writing, is being manufactured and marketed by Brush Instruments, division of Clevite Corp.

The new medium gain dc system features a choice of two individual plug-in amplifiers. One amplifier has high sensitivity of 10 millivolts per chart line (mm) with a stability better than ½ chart line per hour. The other



amplifier features stability, better than 1/10 chart line per hour, and a sensitivity of 50 millivolts per chart line (mm).

Thermal writing feature of the new system provides immediate traces, uniform both in density and width, producing easy-to-read charts.

Circle No. 230 on Subscriber Service Card.

Recorder Designed For Missile Test Vehicles

A recoverable 25-channel on-board digital tape recorder designed for use in missile test vehicles has been developed by Aerophysics Development Corp., a subsidiary of Curtiss-Wright Corp.

As a complete on-board recording



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SAVES MACHINING

REDUCES SCRAP LOSS

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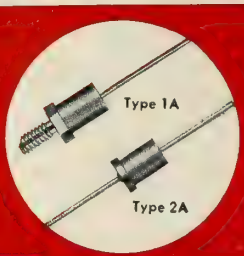
RECTIFIERS

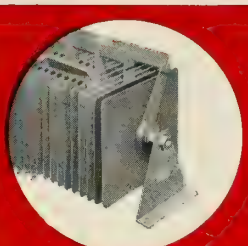
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Type 2A—Rated at 300 ma.

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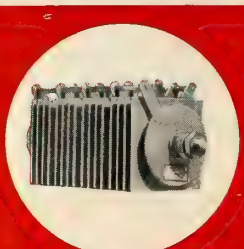


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. . . new products

system, the recorder ties up no groun facilities. The unit may be flown bot as a primary recording system i smaller test vehicles, or as a back-u system for larger missiles with teleme try systems.

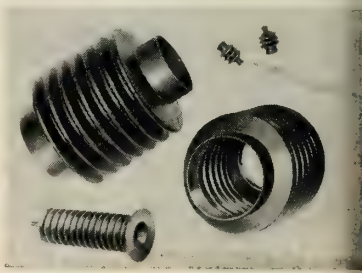
The recorder can be operated t determine time-of-event, magnitude digital relationship and pulse rate fre quencies in excess of 100 cps. Dat resolution is in excess of 5 millisec onds, and extreme accuracy may b attained by use of binary encodin cards if a limited number of event are to be monitored.

Weight of the recorder, includin cylindrical armored protective case, i less than 4½ pounds. Outside diamete 4½ inches, height 4-1/8 inches.

Circle No. 231 on Subscriber Service Card.

Intricate Bellows Typical Of Varied Parts Available

These bellows are typical of th many and varied types of rubber an



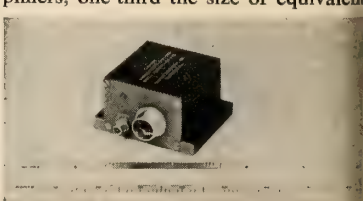
synthetic parts by the Mechanical Rub ber Products Co.

MRPC offers help in designing rubber compounding, molding and fab ricating every conceivable type of me chanical goods in rubber and syn thetics.

Circle No. 232 on Subscriber Service Card.

Transistorized Amplifiers Available in Small Size

Development of transistorized am plifiers, one-third the size of equivalen



tube type units, has been announced by Glennite Instrumentation Div., Gul ton Industries, Inc.

Needing no filament power and only 20% of the plate power required by tube type amplifiers, the amplifiers are designed to amplify signals from high impedance transducers to feed

directly into standard electronic meters, recorders or telemetry equipment.

Operating at a temperature range of −65°F to +240°F., the new instruments are low microphonic voltage amplifiers, specially designed for use in missiles.

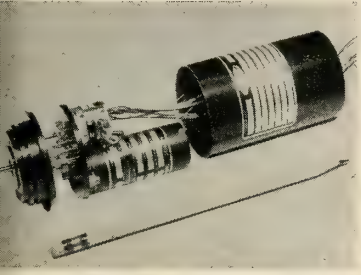
Housed in anodized aluminum cases, the units operate with a recommended minimum load of 10,000 ohms, maintain a voltage gain that is continuously variable between 10 and 100, and perform with negligible vibration noise characteristics.

Circle No. 233 on Subscriber Service Card.

Miniature Turret Package Assembly Developed

A means of assembling precision rotating servo components in miniature turret packages is now available from Mechatrol, a division of Servomechanisms, Inc.

The photograph shows a typical turret package containing a size 11



motor-tachometer, a gearhead, and a potentiometer, all encased in a package less than 5″ long, with a nominal OD of 2¼″. Other servo components, such as transistorized amplifiers, and synchros, can be added as needed. Clutch and limit stops may be added.

Circle No. 234 on Subscriber Service Card.

Miniature Tantalum Capacitor Line Announced

P. R. Mallory & Co., Inc., has announced a brand new line of hermetically sealed tantalum capacitors—first



to offer 150°C operation in so small a size. Known as the M_2 line, the units

SIZE REDUCED AS MUCH AS 61%



Performance Actually Improved!

FANSTEEL

New Sub-Miniature Size S-T-A Capacitors

SOLID TANTALUM

Now you can save more space and at the same time get improved performance when you design these new sub-miniature Fansteel S-T-A capacitors into your products. You get unsurpassed stability over an operating temperature range of −75°C to +85°C... high resistance to vibration and shock which eliminates possibilities of any altitude or humidity problem.

SPECIFICATIONS AND ORDERING REFERENCES

	Catalog Number	Capacity in MFD*	Working Voltage	Surge Voltage
100 SERIES	STA-157	3.5	10	12
	STA-162	2.0	15	18
	STA-167	1.5	20	24
	STA-172	1.2	30	36
	STA-177	1.0	35	42
400 SERIES	STA-457	7	10	12
	STA-462	4	15	18
	STA-467	3	20	24
	STA-472	2.4	30	36
	STA-477	2	35	42
200 SERIES	STA-257	17	10	12
	STA-262	11	15	18
	STA-267	8	20	24
	STA-272	6	30	36
	STA-277	5	35	42
300 SERIES	STA-357	70	10	12
	STA-362	45	15	18
	STA-367	35	20	24
	STA-372	23	30	36
	STA-377	20	35	42

*Standard Capacity Tolerances are minus 15%, plus 25%.

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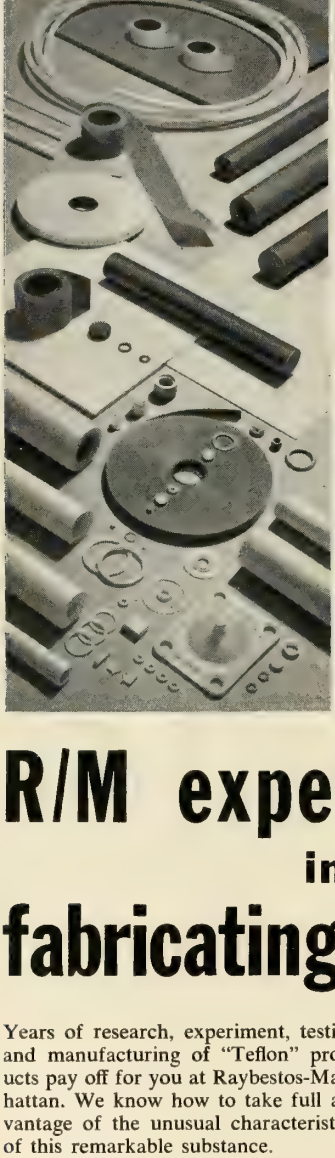
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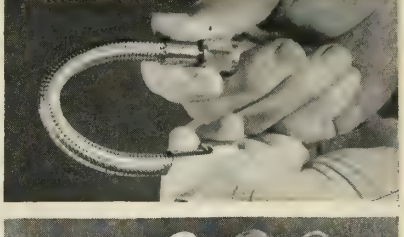
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measure only 0.50 inches in length by 0.287 inches body diameter and 0.484 flange diameter.

These capacitors will withstand up to 150°C temperature and 2,000 cycle vibrations in accordance with MIL-C-3965B, and severe environmental conditions.

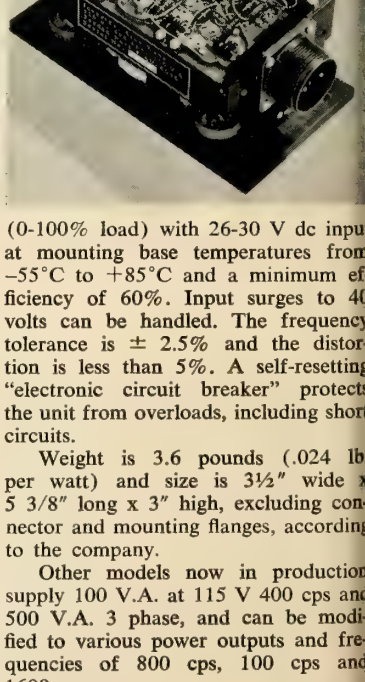
They are available in a wide range of capacities from 11 mfd. 90 volts to 140 mfd. 6 volts at 85°C; and from 11 mfd. 75 volts to 140 mfd. 4 volts at 150°C.

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Lightweight Static Inverter Provides Sine Wave Power

Jordan Electronics announces all-transistorized sine wave power inverters with three power outputs; 100 V.A., and 150 V.A., and 500 V.A.

The 150 V.A., 800 cps unit shown provides 115 V ± 2.5% output,



(0-100% load) with 26-30 V dc input at mounting base temperatures from −55°C to +85°C and a minimum efficiency of 60%. Input surges to 40 volts can be handled. The frequency tolerance is ± 2.5% and the distortion is less than 5%. A self-resetting "electronic circuit breaker" protects the unit from overloads, including short circuits.

Weight is 3.6 pounds (.024 lb. per watt) and size is 3½″ wide x 5 3/8″ long x 3″ high, excluding connector and mounting flanges, according to the company.

Other models now in production supply 100 V.A. at 115 V 400 cps and 500 V.A. 3 phase, and can be modified to various power outputs and frequencies of 800 cps, 100 cps and 1600 cps.

Circle No. 236 on Subscriber Service Card.

letters

Liquid Still Used

To the Editor:

There seems to be a tendency these days among many people to write off liquid-propellant rockets and missiles as obsolescent items.

With solid propellants currently enjoying much publicity and much fanfare, the liquid engine seems to be forgotten.

We at Aerojet are working on both solid and liquid rocket engines. We are currently developing a large liquid rocket engine for the Air Force *Titan* ICBM.

There are about 4,000 people in our liquid rocket plant who don't buy this idea that liquid engines are on the way out.

Joseph J. Kipper
Aerojet-General Corp.
Sacramento, Calif.

There is room in the space age for both liquid and solid systems. Neither are optimim—Ed.

Older Men Welcome

To the Editor:

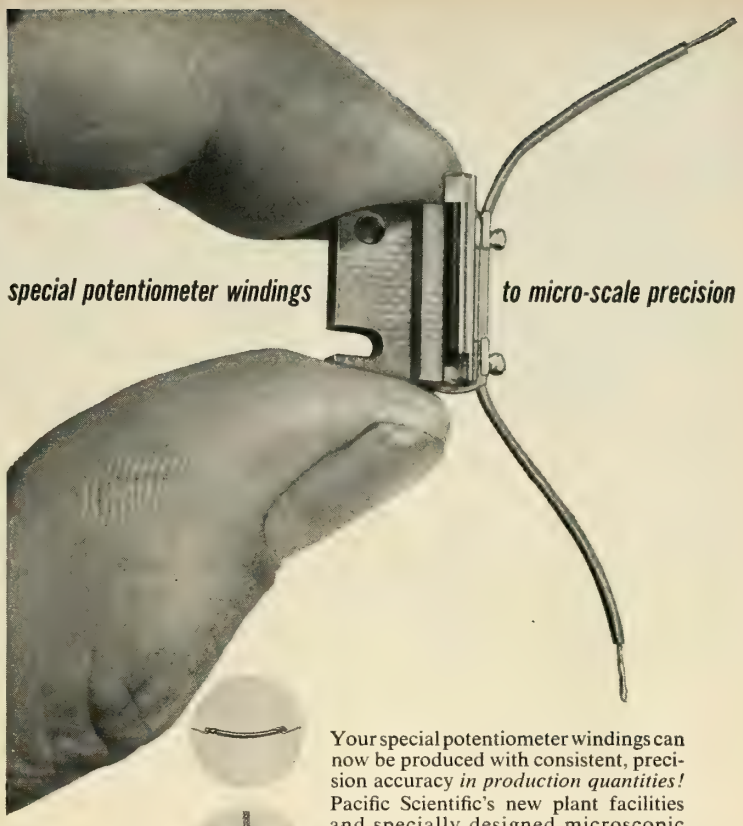
We note with interest the "Letter to the Editor" that appeared in the July 14 issue of m/r, sent in by Mr. James E. Hill of Utica, N. Y., regarding the fact that older engineers are not being utilized by industry.

We wish to advise that Stavid Engineering, Inc., Plainfield, N.J., does and has interviewed and utilized an appreciable number of engineers over the age of forty-five and, as a matter of fact, has on its present staff a good number of men over the age of sixty-five, who have been forced into retirement.

We do not feel that the magical age of forty-five delegates a man to the "industrial scrap heap" and greatly appreciate receiving resumes from the mature engineer.

Eugene B. Kelly
Personnel Director
Stavid Engineering, Inc.

Of interest to our readers is the fact that Stavid not only welcomes job-hunters past 45, but also those past normal retirement age of 65. Of its 250-man engineering force, twenty-five are over 50. All but one were over 45 when they were hired, and ten were over 60 years of age. Stavid acknowledges there is practically no turnover problem. Moreover, the experience of older engineers rubs off on the younger personnel—Ed.





Your special potentiometer windings can now be produced with consistent, precision accuracy *in production quantities!* Pacific Scientific's new plant facilities and specially designed microscopic winding equipment can now provide extremely close linearity tolerances on your special designs whether standard or sub-miniature, and in unusual configurations. Elements are wound to your own specifications on glass, Formvar-covered copper or aluminum mandrels, and X-Y recorder inspection assures uniformity of quality.

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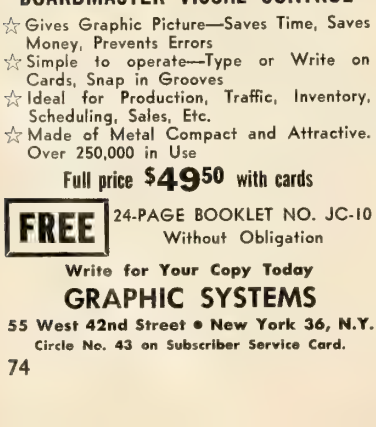
Glass-to-metal sealed ELAPSED TIME indicators. Compact, low cost, tamper-proof. Standard ASA/MIL dimensions, 2½" and 3½" sizes. Easy to read standard size counter registers 1/10 hour steps to 9999.9 or hour steps to 99999. Hermetically sealed. Shielded. Starts, operates continuously from −55°C to +85°C. For 110-125 or 220-250 volts 60 cycle A.C. Bulletin on request. Marion Electrical Instrument Co., Manchester, N. H., U. S. A.

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space age



by Norman L. Baker

Broad overlap of jurisdiction, and the resultant indecision on roles and missions of civilian and military space agencies, is rapidly producing what may be a major impediment to an accelerated national space exploration program. Scientists of both groups constantly refer to the "gray zone," "gray zone in the middle," "broad twilight zone of dual usefulness" and finally, the "gray zone of overlap."

The military scientists, currently the most active space pioneers, have their interest in space necessarily limited by the requirement of defining a project's military usefulness. For instance, many are contesting the decision to place the reconnaissance satellite under military jurisdiction when it will also be invaluable for long-range weather forecasting and world-wide communications.

Less than 24 hours after signing into law legislation establishing NASA, the new civilian space agency, President Eisenhower asked Congress for an additional $125 million for the new agency. In addition, DOD will transfer to the agency $117 million appropriated earlier for non-military space programs.

The million-pound thrust engine, held back for many years because it had no foreseeable future as a military weapon powerplant, is slowly getting underway as a result of plans for manned satellites and rocket-boosted glide bombers. Rocketdyne, in the past few days, has received an Air Force contract to build major components for a single-chambered million-pound unit. Incidentally, the company's foresight is credited with reducing the lead time for this engine by several years. Rocketdyne has continued research on large liquid propellant units, beyond military needs, almost entirely on its own time and expense. This huge engine, with a thrust chamber of 17 feet, has long been past the design stage with no formidable obstacles expected in development.

Liquid engines of 300,000-lb. thrust will be the next Rocketdyne contribution to space age power systems. Several tests of over 10 seconds duration have been made at Santa Susana test facilities. First tests using stock *Atlas-Thor* 150 k (company engineers' own abbreviation for 1,000-lb. thrust) engine developed 290 k with a pressure feed system. Engine was operated with a chamber pressure of approximately 1,000 psi (average pressure—600 psi). Final design for 300 k engine will be turbine fed, operate with an average chamber pressure, and have a combustion chamber 18 inches longer than 150 k unit.

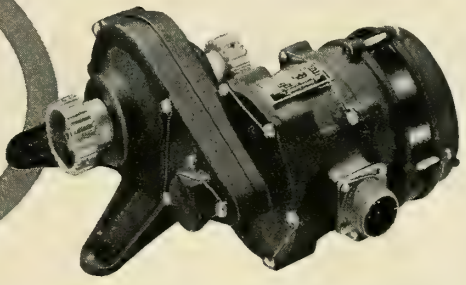
The Army map service, evaluating tracking data from the *Explorer* satellites, expect to reduce mapping errors in the Pacific from ¾ miles to 300 feet. Ultimately—a reduction to 30 feet throughout the world.

Long range missile sites must be built underground in 'hard' positions. This, many military officials agree, is the only way to insure retaliatory capability.



Emergency flap drive on Boeing 707 Stratoliner is provided by Airborne Model R1624-1 special-design rotary actuators. Units are permanently coupled to flap linkage, provide electro mechanical drive in event of hydraulic failure. Output shafts are driven whenever hydraulic system operates, but because of special inertial clutch, rotors do not turn unless energized.

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Specifications: Motor: 200/115 v a-c, 400 cycles, 3-phase, reversible. Speed at rated torque (450 in-lb): 85 rpm±10 rpm. Duty cycle 3 min. on, 27 min. off. Operating range: 102-124 v (line to neutral); 380-420 cps; −65 to +160°F; 0-50,000 ft. Weight 12 lbs.

In addition to offering an extensive line of modular-type electromechanical actuators, Airborne can also meet your requirements for large special designs—linear or rotary. Typical of these special Airborne actuators is Model R1624-1, used on Boeing's new 707 Stratoliner to operate the flaps in the event hydraulic power is lost. At the right are some of the more difficult engineering problems that were presented by this specialized application, along with Airborne's solutions to them.

PROBLEM	SOLUTION
Rotor to be disconnected from output gear stages except when motor is energized in either direction.	Inertial clutch—consisting of small weights in a cage—incorporated between motor and gear train. Makes positive contact with intermediate drive gear only when rotor shaft turns.
Starting torque to be 800 in-lb minimum, with pullout torque of 900 in-lb (±100 in-lb) at 50% motor slip (±10%) under all voltage, frequency and environmental conditions.	Special lightweight motor developed by Airborne to meet these exacting requirements. Rated .9 hp at 10,300 rpm, drawing 2.5 amp maximum.
In event of a jam in actuator transmission or rotor, unit to be fail-safe by permitting rotation of output shaft by torque of 1000-1300 in-lb. Once started, rotation to be maintained by torque not exceeding 100 in-lb.	Special ball-detent, torque-limiting clutch incorporated on output shaft.

Contact us for recommendations on your special actuator requirements . . . or for information on Airborne's standard line of modular design actuators.

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re·lent′less: *a missile that pierces hostile sky to pinpoint its nuclear strike*

When a target's latitude and longitude are marked on this missile's brain, an appointment has been made.

To keep its rendezvous, the Chance Vought *Regulus II* performs miracles of navigation: it will launch stealthily from submarines – nuclear and conventional – from surface craft and mobile shore launchers. It will compensate automatically for wind and weather and for the earth's rotation. It will detour enemy strongpoints, outfox known counterweapons. Closing in on its quarry, it can plummet from over 60,000 feet to smokestack height to escape radar detection.

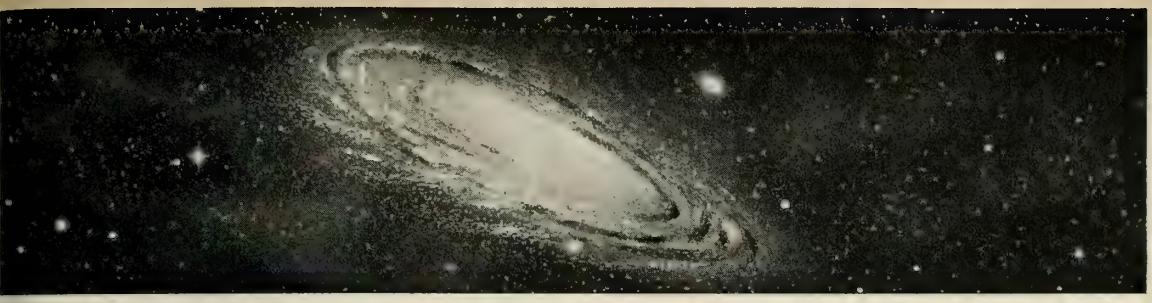
In minutes, *Regulus II* can pierce over 1,000 miles of hostile sky to score a nuclear bull's-eye.

The first of the Navy's nuclear-driven subs, designed to roam the seas as unseen *Regulus II* bases, is now in construction. The missile itself has made over 25 successful flights. Under Navy leash in key locations, it will be a relentless watchdog for peace.

Scientists and engineers: pioneer with Vought in new missile, manned aircraft, and electronics programs. For details on select openings write to: C. A. Besio, Supervisor Engineering Personnel, Dept. P-8.

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Advanced weapons studies at Chance Vought

they range from the ocean floor to deep space

Oceanographers. Astrodynamicists.

Their perspectives are worlds apart. But a broad search for advanced weapons is bringing them and other diverse specialists together at Chance Vought.

Vought's rapid advance into new weapons areas is the natural outcome of 41 years of successful aircraft design and manufacture. A pioneer in the missile field, Vought's *Regulus I* has been operational since 1955. The submarine-based *Regulus II* is now in production. The record-smashing *F8U-1 Crusader* was the predecessor of the all-weather automated fighter, *Crusader III,* which made its first flight this spring. Vought is currently working on the Dyna Soar project as a member of the Boeing space glider development team.

Today at Chance Vought, development work fans out into virtually every known dimension of weapon systems.

ANTISUBMARINE WARFARE (ASW)

Vought is engaged in ASW studies under the Office of Naval Research and the Bureau of Aeronautics. Extensive research and development is being done in the vital detection and classification phases. Goal is to bring detection abreast of destruction capabilities.

Vought applies to this work a preeminent background in sea-going missiles: 10 years' experience in installing, testing, observing Regulus *Fleet missiles; an intimate knowledge of submarines.*

ASTRONAUTICS

Vought is actively studying space research vehicles. Projections of this work point to man in space. Vought's Astronautics strength is experiencing rapid growth: up to a 50-fold increase in less than two years in some groups. Through this astronautics nucleus, Vought swells the space capability of its entire engineering organization.

Vought's major contribution to U. S. man-in-space technology: a rich source of cockpit and capsule knowledge.

WEAPON SYSTEMS PLANNING, ANALYSIS

This body of Vought specialists is determining future weapons requirements; defining new areas for closer evaluation. Under way are studies of nuclear-powered missiles and other original applications for today's explosion of propulsion possibilities.

In this area, breakthroughs already have been scored in antenna design, in high-strength structural steel casting for spatial speeds, and in controls and hydraulics.

Launch Systems Engineer (Preliminary Design)

A seasoned design engineer with field experience. To concentrate on improving orderliness, reducing volume of support equipment. Should be able to design the field system, and prescribe component equipment.

ASW Detection Specialist

Physicist or Electronics Engineer with Sonar or electromagnetic detection experience. Familiarity with submarine tactics, equipment highly desirable. To devise new methods for submarine detection, conduct necessary preliminary analyses, and prepare information leading to hardware design for laboratory testing.

Astrodynamics Specialist

Physicist, Engineer, Astronomer with knowledge of orbit calculations, and experience in digital computers and accurate integration techniques for computing space trajectories.

Preliminary Design Engineer

Capable of turning approximate dimension, thrust, payload and mission information into usable configurations. Requires the mechanical ability to provide for separation of stages; a good feel for missile weight and balance; ability to devise reliable, uncomplicated control systems.

Qualified scientists and engineers who would like to evaluate more thoroughly the opportunities afforded today at Chance Vought are invited to write in confidence to Mr. A. L. Jarrett, Manager, Advanced Weapons Engineering, Dept. P-8.

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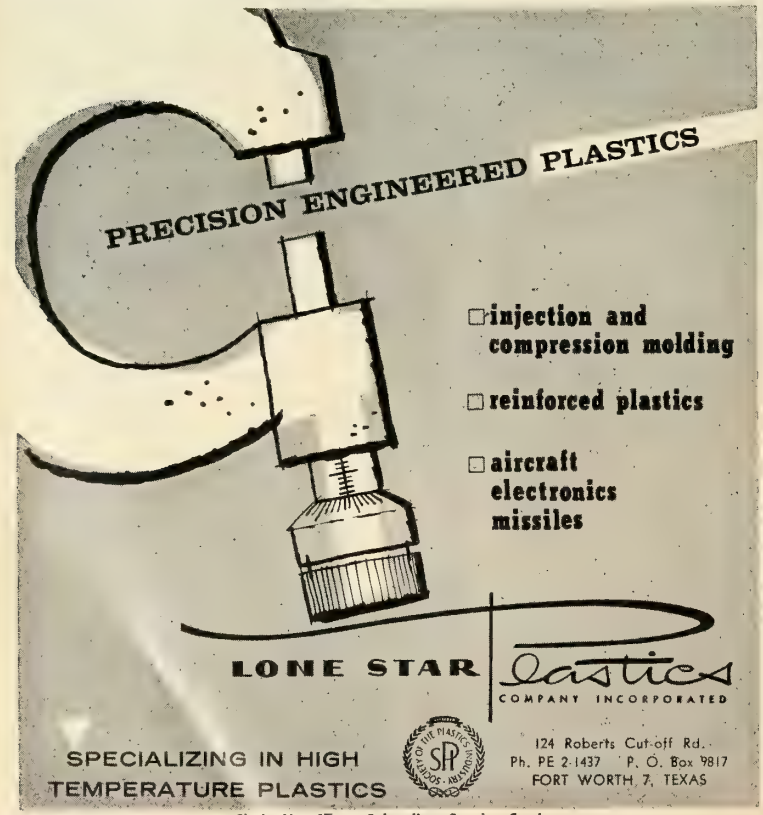
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Maximum Line Pressure: . . . . . 5,000 psi
Accuracy: . . . . . ± 1% full scale
Excitation Frequency: From 60 to 20,000 cps
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missile business

by Seabrook Hull

"Look at the missile next to you. A year from now it won't be there!" The missile rationalization we've been warning you about for the past several months is about to begin. As one high Pentagon official puts it: "It will be an agonizing reappraisal." Insofar as humanly possible, it will:

—ignore the vested interests and desires of any specific military service or industrial grouping.

—relate actual operational capability, rather than claims and dreams, to the missions essential to the execution of basic Western strategy, namely an in-being readiness for massive retaliation.

—evaluate the cost in dollars in each instance against competitive systems and in relation to over-all cost and total funds and resources available.

This reappraisal will be conducted by the Office of the Secretary of Defense, rather than by the Joint Chiefs of Staff or the military services, either individually or collectively. Those responsible for making the basic decisions are well aware that some of the claims of Army, Navy or Air Force for their pet birds may be considerably colored.

There may be some surprises. For example, both *Thor* and *Jupiter* may be tossed out of the running as durable weapons systems. Actually, there are two alternative approaches to this one. First, a decision can be made between *Thor* and *Jupiter* as *the* IRBM, but this cannot be done until such time as the full *Thor* has successfully completed three flights and a fair comparison can be drawn. Second, however, both can be relegated to the primary role of space-flight propulsion units, and *Polaris* be given the main land-based IRBM job. This means a few *Thors* or *Jupiters* would be built for the interim, but that big production would go to *Polaris.*

Defense Department is vitally concerned because none of the big liquid propelled missiles assure the U.S. of the massive retaliation capability so necessary to the military stand-off with Russia. Yet DOD officials argue, there is nothing inherently in the *Polaris* system that precludes its use on land, as well as underwater. *Polaris,* they pointed out, could not only be fired "instantaneously" (it uses solid propellants and requires no last-minute fueling), but here is an instance where two important roles could be filled at the cost of one.

A similar choice will be made within six months between *Atlas* and *Titan.* Defense Secretary McElroy is convinced that we neither need nor can afford both. Whichever one is dropped, however, as a weapon will have some of its better features incorporated in the other. If we had to guess, we'd say *Titan* goes and *Atlas* stays—though some *Titans* would be completed for test purposes and as space flight vehicles.

Minuteman cannot be picked as a substitute for either *Atlas* or *Titan.* It is scheduled too far into the future. Reason for this is *Minuteman's* combined limitation of maximum miss distance vs. payload. In order to guarantee the same minimum impact on target as *Polaris, Jupiter* or *Thor,* taking into account best guidance currently available, the proposed solid propellant ICBM would have to have approximate a 50 megaton warhead compared to three megatons in *Atlas.* As presently conceived, *Minuteman's* warhead is on the order of one-half megaton. Either more accurate guidance for a smaller maximum miss distance or better propulsion for a bigger warhead, or both, will have to be achieved before *Minuteman* becomes a practical consideration. Despite Air Force enthusiasm for the concept, the Secretary of Defense's office is insisting that work concentrate in these two areas before spending a lot of hard-to-get money on other aspects of the weapons system.

contract awards

LAST MINUTE AWARDS

H. B. Zachry Co. of San Antonio, Texas gave Parabam, Inc. $280,000 for design and fabrication of twenty-two astrodome type tracking camera shelters.

NAVY

By Aviation Supply Office:

Ronan & Kunzl, Inc. received $258,720 for trailer, liquid oxygen.

By Purchasing Office:

Bendix Computer Div., Bendix Aviation Corp., received $49,500 for computer, digital.

Hallamore Electronics Co. received $27,804 for telemetering equipment.

By Bureau of Ships:

Western Electric Corp. received $270,000 for the production of magnetron tubes capable of generating ten-million-watt radar pulses.

By Bureau of Ordnance:

Western Electric Co. received $3.7 million for the production of weapon direction equipment.

By Bureau of Ships:

United States Rubber Co. received $29,828 for conducting a study directed toward development of room temperature vulcanizing elastomers or absorption of neutrons.

By District Public Works Office, Eleventh Naval District:

W & M Investment Co. received $283,693 for construction of guided missile support facilities.

AIR FORCE

By Memphis Air Force Depot:

Ronan & Kunzl, Inc. received $74,900 for hose assembly-transfer liquid oxygen.

Welding and Steel Fabrication Co., Inc. received $78,750 for hose-assembly-transfer liquid oxygen.

By HQ, Middletown Air Materiel Area:

Gas Industries Inc. received $1,682,301 for liquid oxygen and liquid nitrogen.

By HQ, AFMTC, ARDC:

Pan American World Airways, Inc. received $67,758,536 for increase in funds.

By Cmdr. HQ, AMC, Wright-Patterson AFB:

Keco Industries, Inc. received $78,650 for dehumidifiers, film drier, engineering data and technical data and ground support equipment.

Ladish Co. received $85,803 for development procedures for the production of sound high-strength steel forgings for aircraft parts by the superimposition of vibratory forces, in addition to normal forging forces.

By HQ, AFFTC, ARDC:

General Electric Co., Missile & Ordnance Systems Dept., received $98,557 for investigation and evaluation of methods of lubrication for reducing of frictional wear.

Research & Advanced Development Div., Avco Mfg. Corp., received $58,411 for fluorine compatibility test equipment.

Haskel Engineering & Supply Co. received $76,505 for helim booster compressor.

Cook Electric Co., Cook Research Laboratories Div., received $64,612 for engineering study.

G. W. Galloway Co. received $91,857 for nitrogen & helium distribution system.

Motorola, Inc. received $106,767 for development of air operational prototype remote data acquisition and transmission system.

Cook Electric Co. received $79,352 for development of mono-rail water brake vehicle.

Motorola, Inc. received $61,425 for microwave data transmission system.

ENGINEERS
SCIENTISTS

advanced
missile
and space
vehicle engineering

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RELIABILITY ENGINEER

EE or ME degree, plus 5 to 15 years' professional experience.

Develop and integrate reliability programs, methods and procedures for electrical, electronic, mechanical and electro-mechanical aspects of missile systems and equipments.

THERMODYNAMIC ENGINEER

ME or AE degree, plus 5 to 10 years' experience in aerodynamic heating problems.

Initiate, plan and execute analytical and experimental studies related to aerodynamic heating and thermodynamic aspects of nose cone development.

MISSILE TELEMETRY & COMMUNICATIONS ENGINEERS

BS, MS, PhD in EE, plus 3 to 10 years' experience covering advanced circuitry, telemetry and infrared applications

Develop theory and analyze operation requirements for missile communications; design and develop systems.

PROPULSION ENGINEERS

BS, MS, PhD in Chemistry, Physics or Aeronautical Engineering, plus 6 to 10 years' experience in advanced propulsion systems.

Analyze requirements and provide specifications for propulsion systems of diverse types (liquid and/or solid propellant, nuclear, turbo- and ram-jet). Integrate system analysis and design; establish system and sub-system ground and flight test requirements.

●

The major technical programs at MOSD are carried on under long-term prime development contracts. The climate here is one of scientific curiosity pursued under ideal laboratory conditions.

Please send your resume to:
Mr. Richard Eddy,
Div. 43 MF

MISSILE & ORDNANCE SYSTEMS DEPARTMENT
GENERAL ELECTRIC

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Philadelphia 4, Pa.

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. . . contracts

Electronic Associates Inc. received $38,948 for computer plotter system.

Stavid Engineering, Inc. received $350,000 for development of a central telemetry facility.

Cook Electric Co. received $38,598 for additional requirements and complete funding of supersonic II test vehicle.

By HQ, Rome Air Force Depot:

Bendix Aviation Corp., Bendix Radio Div., received $2,000,901 for radar set in accordance with specifications.

Arthur D. Little, Inc. received $25,670 for liquid helium producing facilities which will include cryostat gas holder and cold trap.

ARMY

By Engineer District, Mobile, Corps of Engineers:

B. B. Saxon received $35,784 for construction of addition to decontamination room at propellant fuel facility No. 7 at Elgin AFB.

By San Francisco Ordnance District:

Jennings Radio Mfg. Corp. received $27,898 for supplies & services for design & development of R&D contractors (guided missiles & related materials).

Sanford Research Institute received a contract for economic analysis of coat, availability and capability of air defense systems, R&D.

University of California received $30,000 for influence of environment on fracture of metals.

By Engineer Procurement Office:

Air Products Inc. received $2,863,082 for generating plant, oxygen-nitrogen.

By Engineer District, Los Angeles:

Matich Bros. and M. M. Sundt Construction Co. received $2,811,482 for missile silo, equipment terminal facility, tunnels.

By HQ, Redstone Arsenal, Ordnance Missile Command:

The Martin Co. received $61,733 for furnishing and supplying 48 man-months of fully qualified personnel for technical assistance to guided missile school instruction.

By Signal Supply Agency:

Metavac, Inc. received $37,774 for industrial preparedness measure for near infrared filters and intermediate infrared filters.

Sylvania Electric Products, Inc. received $26,122 for crystal unit.

Cooper Development Corp. received $32,123 for rocket motors.

By Signal Supply Agency:

Radioplane, a div. of Northrop Aircraft Inc. received $9,069,071 for low speed drone systems.

General Instrument Corp. received $69,000 for radiosonde set.

Collins Radio Co. received $740,263 for digital date computer.

Stevens Institute of Technology received $56,065 for services and materials for 24 months of study of plasma acceleration.

RCA Service Company, Div. of Radio Corp. of America, received $370,000 for services and materials to conduct a study leading to the establishment of improved cables and connectors for guided missile systems; $63,462 for services and materials for twelve months to conduct a research program on generation of "cool" electrons for low noise.

New York University received $50,000 for services for research study concerning paramagnetic resonance in the solid state.

RCA Laboratories, Div. of Radio Corp. of America, received $75,505 for investigation on high temperature photo-voltaic solar energy converter.

Philco Corp. received $300,000 for logical processor and computer.

North American Aviation Inc. received $89,025 for computer.

The Ramo-Wooldridge Corp., Control Systems Div., received $13,599,683 for automatic data processing system test facility.

Interstate Electronics Corp. received $278,766 for wide band closed circuit TV systems.

G. C. Dewey Co., Inc. received $61,521 for component evaluation report, consisting of analysis and determination as to the comptability and usefullness of components of present air defense systems.

Collins Radio Co. received $1,059,209 for one year extension of investigations of theory and application of scatter circuits in tactical systems, plus developing a tropospheric scatter system.

Stanford Research Institute received $94,153 for additional research and development of micro-wave filters and coupling structures for 12 months.

Princeton University received $31,000 for additional research work for the investigation of the optical detection of hyperfine resonance in alkali metals.

Leland Stanford Jr. University received $99,800 for additional study on program solid state two level high power masers.

University of Illinois received $35,000 for additional research work on moon-relay transmission.

By Springfield Ordnance District:

Kaman Aircraft Corp. received $33,593 for proposed study of pressure estimation for barometric arming and fuzing of missiles.

Yale University received $30,134 for research program in low temperature physics.

By Ordnance District, Los Angeles:

Douglas Aircraft Co. Inc., received $71,636 for repair parts for *Nike* system.

Firestone & Tire & Rubber Co. received $430,000 for replenishment requirements of spare parts for *Corporal* missile.

Gilfillan Bros. Inc. received $73,293 for furnishing of depot replenishment repair parts for the *Corporal* missile system, and 2 contracts totalling $298,000 for requirements of spare parts for *Corporal* missile.

Firestone Tire & Rubber Co. received $27,000 for field service engineering in connection with *Corporal* missile and ground handling equipment, and $71,000 for repair parts for guided missile, artillery M2 and related ground handling equipment.

Gilfillan Bros. Inc. received $962,370 for engineering services related to the *Corporal* missile system.

By Boston Ordnance District:

Allied Research Associates, Inc. received $49,677 for study of nuclear weapons effects in *Jupiter* nose cone.

National Academy of Sciences received $75,000 for a study program to analyze and assess the science of metallurgy.

Mass. Institute of Technology received $100,000 for experimental and theoretical research in microwave tubes.

Horizons Inc. received $29,864 for research on the mechanism of growth and properties of exide whiskers.

Rias Inc. received $26,267 for studies regarding delay-time on face-centered cubic metals and alloys.

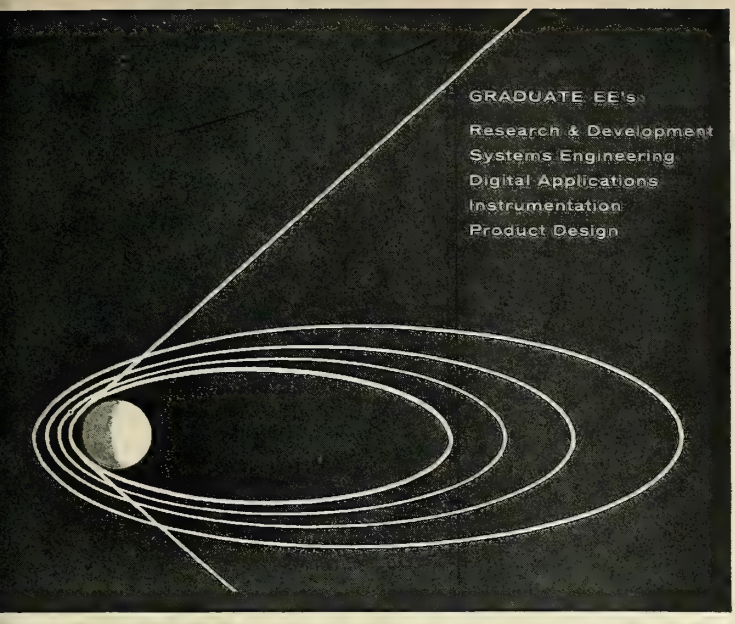
Rocketdyne Gets Contract For Million-Pound Engine

Rocketdyne, a division of North American Aviation, Inc., has received an Air Force contract to begin development of major components for a rocket engine in the one-million-pound thrust class.

The contract, awarded by Wright Air Development Center after design competition, is the first step toward the thrusts that are believed to be essential in manned interplanetary exploration, according to Rocketdyne.

At the same time, the Air Force under separate contract, extended Rocketdyne development of a previously undisclosed engine to provide thrust in the intermediate range between current propulsion systems and the million pound unit.

Both engines covered in the contract are liquid propellant systems, similar in principle to Rocketdyne engines for the *Atlas* ICBM, the *Thor* and *Jupiter* IRBM's and the Redstone missile.



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Despite the magnitude of the undertaking, guiding a vehicle on a >428,000 mile return trip to the Moon...or directing an interplanetary probe into Mars' orbit depends fundamentally upon the basic technologies already developed to guide surface-to-surface ballistic missiles into their trajectories.

The great technical challenges of guidance for space exploration lie in the unprecedented accuracies, reliabilities and long operative life-spans that must be engineered into the guidance systems.

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Technical Recruitment Supervisor

CHRYSLER CORPORATION
MISSILE DIVISION
P. O. Box 2628
Detroit 31, Michigan

. . . business

Atlas Corp. May Acquire Summers Gyroscope Co.

The stockholders of Summers Gyroscope Co. have voted to give Atlas Corp. the opportunity to gain eventual control of Summers in exchange for an additional loan from Atlas of $245,000.

Under the Loan agreement, Atlas would be entitled to obtain one share of Summers stock for every 49¢ worth of debt that it wished to cancel prior to June 15, 1963, the final maturity date. The arrangement would also apply to a previous $150,000 loan from Atlas Corp.

GM, Callery, Thiokol Form New Missile Team

A working agreement aimed at developing advanced devices in the field of guided missiles and space travel was announced last week in joint statements from General Motors, Callery Chemical Company and Thiokol Chemical Corporation.

Harlow H. Curtice, president of General Motors; E. G. Sanner, president of Callery; and J. W. Crosby, president of Thiokol, made the joint announcement. Under the agreement, the three companies will "apply their cooperative efforts toward the attainment for the United States of world leadership in the field of astronautics."

The announcement went on to explain that the three firms will pool technology in a concentrated effort to advance development, but the agreement in no way "restricts individual research, sales or production programs of each company."

The official announcement said that the agreement is limited to the field of astronautics, which "includes all branches of technology pertaining to guided missiles, space vehicles and other devices traversing the regions of space, or the earth's atmosphere, under conditions that aerodynamic forces are inadequate to support the weight of the object."

Individual contributions to the team will work about this way:

General Motors, through its Allison and AC Spark Plug divisions, will provide the talent for air breathing engines, guidance systems, missile components and structures. Callery will provide propellant components for space vehicles; and Thiokol will add its capabilities in solid and liquid fueled rocket propulsion systems, including the facilities of Reaction Motors, Inc., recently acquired by Thiokol.

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Active and growing line of explosive-actuated devices for missile and aircraft application. Contacts at both engineering and purchasing levels. Regions open are Northeast, Southeast, Midwest, Southwest. Send organizational details. Box 115, Missiles & Rockets, 8943 Wilshire Blvd., Beverly Hills, Calif.

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This West Coast organization is seeking a Sales Engineer to sell nationally accepted hydraulic line to aircraft and missile industry. Must have proven ability to sell technical products. Engineering background, aircraft experience or familiarity with hydraulics desirable but not mandatory. Give complete resume and salary expected with first letter.

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Washington, D.C.

Advertising correspondence should be addressed to Advertising Sales Manager, Missiles and Rockets, 17 East 48th Street, New York 17, N.Y.

REGIONAL OFFICES:

New York City: 17 E. 48th St., New York 17. Edward D. Muhlfeld, Advertising Sales Manager; P. B. Kinney and G. T. O'Mara, regional adv. mgrs. Phone: PLaza 3-1100.

West Coast: 8943 Wilshire Blvd., Beverly Hills, Calif. Fred S. Hunter, manager; Walton Brown, regional adv. mgr. James W. Claar, regional adv. mgr. Phones: BRadshaw 2-6561 and CRestview 6-6605.

Chicago: 139 N. Clark St., Chicago 2, Ill. George E. Yonan, regional adv. mgr. Phone: CEntral 6-5804.

Cleveland: 244 Hanna Bldg., 1422 Euclid Ave., Cleveland 15, Ohio. Douglas H. Boynton, regional advertising manager. Phone: PRospect 1-2420.

Detroit: 201 Stephenson Bldg., Detroit 2, Mich. Kenneth J. Wells, regional advertising manager. Phone: TRinity 5-2555.

Canada: Allin Associates, 12 Richmond Street East, Toronto 1, Ontario. Phone: EMpire 4-2001. Allin Associates, 1487 Mountain St., Suite 4, Montreal, Que.

Geneva: American Aviation Pubs., 10 Rue Grenus, Geneva, Switzerland. Anthony Vandyk, European Director.

London: The AAP Company, 17 Drayton Road, Boreham Wood, Hertfordshire, England. Phone: Elstree 2688. Cable address: STEVAIR, London.

Paris: Jean-Marie Riche, 11 Rue Condorcet, Paris (9e), France. Phone: TRUdaine 15-39. Cable address: NEWS AIR PARIS.

advertiser's index

AMP Inc. 83
Aerojet-General Corp., Sub-The General Tire & Rubber Co. 60, 78
Aeronutronic Systems, Inc., Sub-Ford Motor Co. 61
Airborne Accessories Corp. 75
Aircraft Armaments, Inc. 57
American Instrument Co. 21
American Machine & Foundry Co. .. 6
Avco Mfg. Corp., Crosley Div. 63
Baldwin-Lima-Hamilton Corp., Standard Steel Works Div. 10
Morris Bean & Co. 24
Belfab Corp., The 52
Bell Aircraft Corp. 65
Bendix Aviation Corp., Bendix Products Div. 8
Blocksom & Co. 19
Boeing Airplane Co. 39
Chance Vought Aircraft, Inc. 76, 77
Delco Radio Div., General Motors Corp. 33
Douglas Aircraft Co., Inc. 44
Edgewater Steel Co. 69
Thomas A. Edison Industries, Inc. .. 67
Electro Instruments, Inc. 84
Electrosnap Corp. 36
Fansteel Metallurgical Corp. 70, 71
Gabb Special Products, Inc. 78
General Mills, Inc. 4
G. M. Giannini & Co., Inc. 23
Graphic Systems 74
Hallamore Electronics Co., a Div.-The Siegler Corp. 18
Hughes Aircraft Corp. 64
Hydraulic Research & Mfg. Co., Div.-Bell Aircraft Corp. 27
Industrial Engineering Corp. 68
James, Pond & Clark, Inc. 66
Johns Hopkins University Operations Research Office 41
Kaman Aircraft Corp. 59
Kett Technical Center, Inc. a Sub.-U.S. Industries, Inc. 73
Kintel (Kay Lab.) 2
Kollmorgan Optical Co. 15
Lone Star Plastics Co., Inc. 78
Magtrol, Inc. 57
Mallory-Sharon Titanium Corp. 48
Marion Electrical Instruments Co. ... 74
McDonnell Aircraft Corp. 54, 55
Nems-Clarke Co. 58
Northam Electronics, Inc., Sub.-Norris Thermador Corp. 78
Pacific Scientific Co. 56
Raybestos-Manhattan, Inc. 72
Raytheon Mfg. Co. 26
Rucker Co., The 35
Simmons Fastener Corp. 22
Standard Steel Works Div., Baldwin-Lima-Hamilton Corp. 10
Telecomputing Corp. 60
Temco Aircraft Corp. 62
Tube Methods, Inc. 65
Union Switch & Signal, Div.-Westinghouse Air Brake Co. 53
United States Gasket Co. 25
Vapor Heating Corp. 51
Vickers, Inc., Div.-Sperry Rand Corp., Marine & Ordnance Dept. 30
Vickers, Inc., Div.-Sperry Rand Corp. 42, 43
Voi-Shan Mfg. Co. 3
Welwyn International, Inc. 61

EMPLOYMENT

Chrysler Corp., Missile Div. 81
General Electric Co. 80, 81

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NEW PRODUCT BRIEFS

SISTORIZED OSCILLATOR. Tran-ed sine wave oscillator replaces fork designs for aircraft, missile ther electronic applications. The act unit, about 2" x 2" x 3" in size, n adjustable frequency set range cycles per second to 200 kcps. It ilable in plug-in or header type uction. General Controls Co.

No 237 on Subscriber Service Card.

SDUCER LINE. For applications missile and process control fields. nits can be manufactured to a range of specification and are be- to offer significant advantages in ations requiring conversion of linear motions into large angular ns. Research Consulting Associates.

No. 238 on Subscriber Service Card.

CTION MECHANISM. A series of s utilizing a gearbox, clutch and mechanism capable of a 7 million reduction. This provides a shaft ro- as slow as one revolution in 32 The clutch will drive a load of 45 and the return spring will exert 65 oz.-in. of torque. Dalmotor Di- Yuba Consolidated Industries, Inc.

No. 239 on Subscriber Service Card.

DDERS. A line of 8-4-2-1 Binary- decimal shaft encoders has been nced. Five models cover a range o 6 decades, providing 100 counts rn, and employing a standard size Ord synchro mount. The units use lecting brush V-scan logic, elimi- external anti-ambiguity electronics. n Division, United Aircraft Corp.

No. 240 on Subscriber Service Card.

T SOURCE. A new light source, a ium Art, has been adapted for chromators, greatly increasing pre- and giving true colors. This com- ively new light source has the st intensity ever developed for power or oil emersion microscopy, related fields. Cambridge Ther- c Corp.

No. 241 on Subscriber Service Card.

INDICATOR TUBE. An addition to its line of Nixie Indicator Tubes called the Jumbo Nixie—type BD-307. This three inch diameter, all electronic in-line indicator, is designed to meet the needs of visual presentation at viewing distances of over 150 feet. Low power and rugged construction are additional features. Burroughs Corp., Electronic Tube Division.

Circle No. 242 on Subscriber Service Card.

SPECTROMETER. A high precision Multichannel Scintillation Spectrometer is now in production. The system has 120 channels, taken 20 at a time for rapid, accurate analyses of pulse height distributions. Some applications are high speed scintillation spectrometry, pulse height analysis of low intensity sources, spectral analyses with a minimum of decay corrections for short-lived isotopes. Baird-Atomic, Inc.

Circle No. 243 on Subscriber Service Card.

POWER RELAY. A miniature version of a power relay in a clear polystyrene enclosure, with octal plug-in header. This relay is available up to 3 PDT, with standard contacts rated at 10 amps, and can be wired for double make or break operations, AC or DC coil. Kurman Electric Co., Div. of Norbute Corp.

Circle No. 244 on Subscriber Service Card.

TAPE READER. Dykor Model C301, a photoelectric perforated tape reader, is available to handle any one of the standard punched tape widths. Reading speeds range from 100 characters per second to 750 characters per second. The fast start-stop feature permits intermittent reading of tapes at slower rates. Digitronics Corporation.

Circle No. 245 on Subscriber Service Card.

CHOPPER. A new Millivac type DCM-99K-1 DC modulator is a single pole double throw chopper, which has less than 5 microvolts DC offset and drifts less than 2 microvolts over a long period of time, according to the manufacturer. Millivac Instruments, Division of Cohu Electronics, Inc.

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• • Advertisements

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125
126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150
151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175

• • Missile Literature

200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224
225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245	246	247	248	249
250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	274
275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299

• • New Missile Products

For Other Information Give Page Numbers:_____

MISSILE LITERATURE

RELIABILITY STUDY. The Electro Motive Manufacturing Company has published a six-page, two-color folder, "Reliability Study of Silvered Mica Capacitors . . ." The report shows how "debugging" assures greatest dependability for long life.

Circle No. 200 on Subscriber Service Card.

FRAME GRID TUBES. "Amperex 'PQ' (premium quality) Reliable Frame Grid Tubes," a new brochure, contains a detailed description of the advance frame grid tube and has been issued by Amperex Electronic Corporation. The brochure contains a detailed description of what the frame grid is, how it is made, specific military and industrial applications, and a working definition of tube life and reliability.

Circle No. 201 on Subscriber Service Card.

TECHNICAL PUBLICATIONS. A new six-page brochure, "Technical Publications and Reports," is now available from Burns and Roe, Inc. The folder describes the services of a department of the engineering firm specifically organized to handle technical writing, editing, layout, illustration, editorial production and reproduction.

Circle No. 202 on Subscriber Service Card.

HELIPOT DATA. The Beckman Model 15 IM 461, a new 115-volt, 400-cycle Size 15 Inertia-Damped Servomotor, is described in detail in Data Sheet 1303, issued by Helipot Division of Beckman Instruments, Inc.

Circle No. 203 on Subscriber Service Card.

POTENTIOMETERS. A brochure showing the products of Electro-Mec Laboratory, Inc. is now available, detailing the company's specialization in design and manufacture of ultra low torque potentiometers of extreme precision.

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RADIAGRAPH MACHINE. An eight-page booklet shows the features of Airco's No. 20 Radiagraph Flame Cutting Machine. The No. 20 Radiagraph is a portable, motor-driven, straightline track-guided machine. Limited contour, circular and curved cutting can be done by using suitable accessories, also described in the booklet.

Circle No. 205 on Subscriber Service Card.

PLASTIC COATINGS. Furane Plastics, Incorporated, has issued a bulletin on Epocast Coatings. The Epocast epoxy, polyurethane, furane resins, and their curing agents are described in the brochure.

Circle No. 206 on Subscriber Service Card.

HYDRAULIC CYLINDERS. Bulletin JH-104N, covering the Hydraulic Cylinders manufactured by the Miller Fluid Power Division of Flick-Reedy Corporation, has been designed to serve as a pra textbook embracing all importan pects of the use of hydraulic cylinders.

Circle No. 207 on Subscriber Service

NITROUS OXIDE. An eight-page chure describes the types of n oxide installations specifically des for use in leak detection of press systems. It is available from Ohio ical & Surgical Equipment Com and discusses the flexibility of Nitr installations.

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METALLIZING PROCEDURES. A chure covering all phases of metal has been published by the Metal Company of Los Angeles. The pu tion is illustrated and explains in the advantages of metallizing—or spraying—and offers five separate of use.

Circle No. 209 on Subscriber Service

SEMICONDUCTORS. Covering th line of semiconductor products man tured by the Semiconductor Divisi the Hoffman Electronics Corpor Evanston, Illinois, a new folder is available.

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CATALOGUE. Glasseal Products pany, Inc. has announced a new logue which shows the developmen the company, of a new one-piece struction header that is said to b advantage to all electronic man turers who use square or rectan cans to package their units.

Circle No. 211 on Subscriber Service

RUBBER COMPONENTS. A six- bulletin outlining the company faci and capabilities in the manufactur rubber and plastic components is available from the Ohio Rubber pany. Entitled "Customeering," the letin explains Ohio Rubber service cluding compounding and coloring, signing and building molds and special tools and fixtures.

Circle No. 212 on Subscriber Service

BRUSH LINE. A complete line of bon and graphite brushes for all of rotating electrical machinery is scribed and illustrated in a 12-p two-color bulletin, offered by Speer bon Company.

Circle No. 213 on Subscriber Service

SAFETY ENCLOSURE. Technical Bu A-11, published by S. Blickman, Inc. scribes an all-purpose safety encl with modular construction that a one or a combination of these uni be used in any desired arrangement

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26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125
126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150
151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175

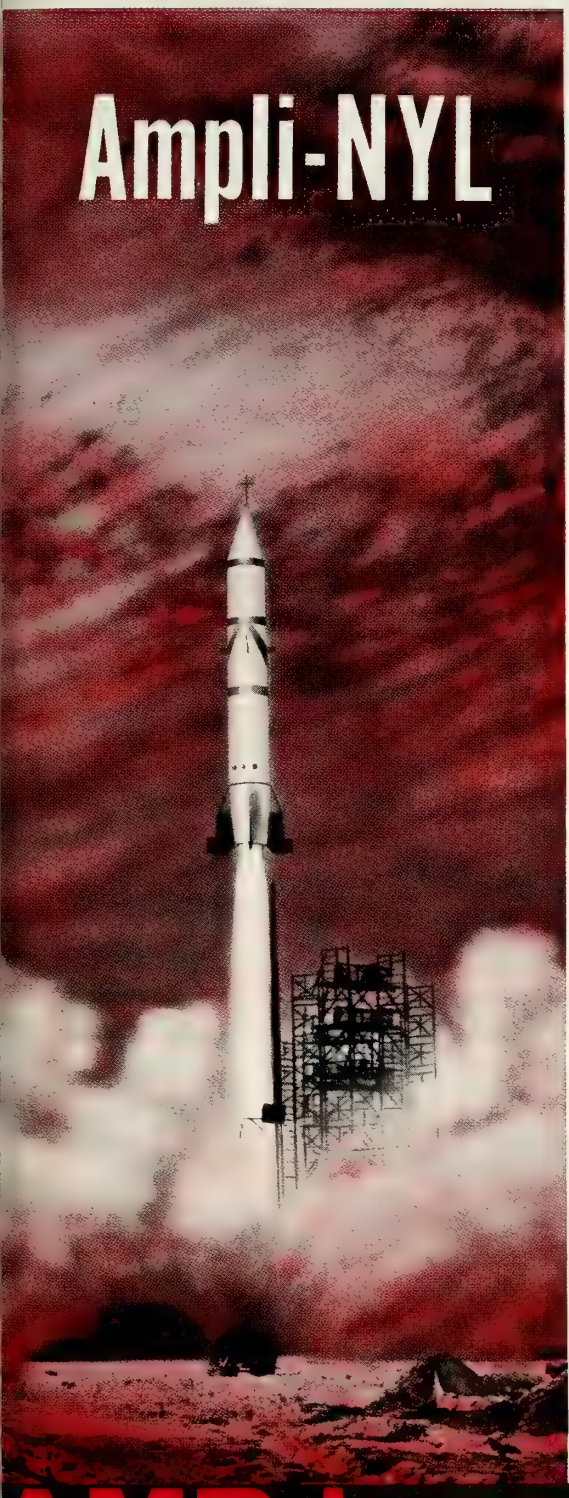
• • Missile Literature

200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224

• • New Missile Products

225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245	246	247	248	249
250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	274
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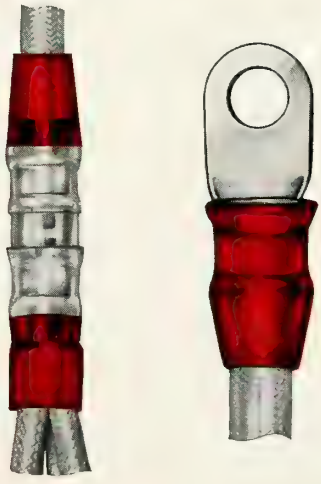


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Diode Manufacturer uses Electro Instruments X-Y Recorders to plot Zener diode characteristics

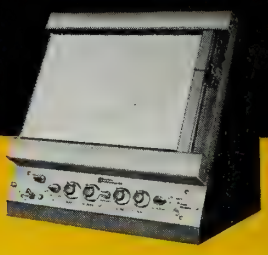
INCLUDES PLOT WITH EACH DIODE

International Rectifier Corporation, manufacturers of Zener diodes, plots the reverse breakdown characteristics of each diode. These plots accompany the diode to the customer and provide an immediately useful graphic description of the individual unit's transfer characteristics. As shown below, the plots are made with an Electro Instruments Model 100 X-Y Recorder.

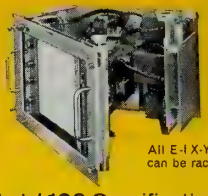
These proven recorders fulfill the most demanding operational and performance requirements. They possess such advanced design features as transformer-isolated servo-controlled cable drives to eliminate backlash, an internal vacuum hold-down and carriage slewing mechanism for easy paper insertion, and a positive paper indexing provision for measurement repeatability. Operating controls are kept to a minimum and are logically grouped for maximum operator convenience.



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AUGUST 18, 1958



missiles and rockets

MAGAZINE OF WORLD ASTRONAUTICS

News and Business Edition

AN AMERICAN AVIATION PUBLICATION



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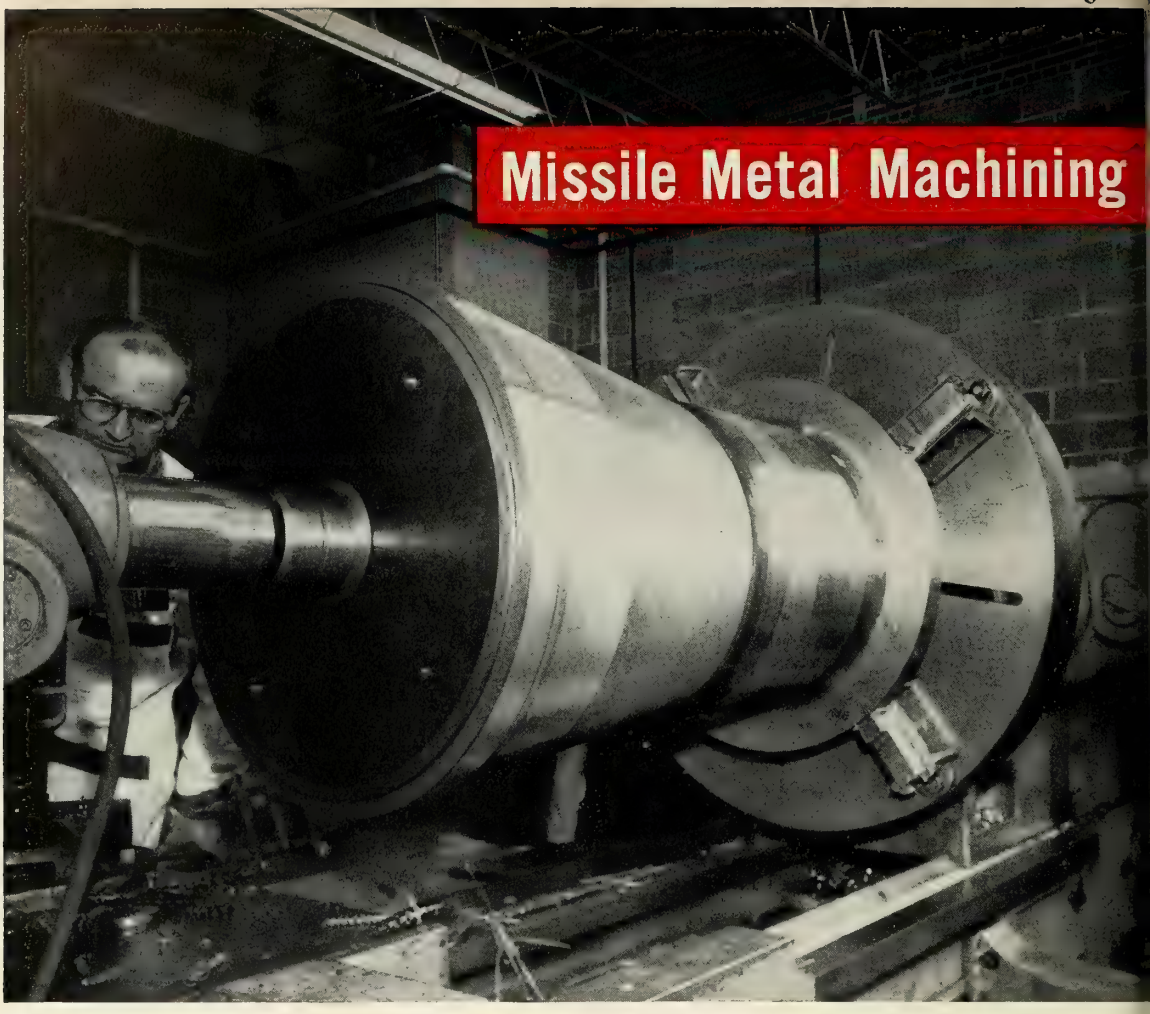
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AUGUST 18, 1958
VOL. 4, NO. 7

missiles and rockets

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editorial viewpoint . . .

Awaiting Presidential action is the appointment to one of the most important posts in U.S. military history: the Director, Research and Engineering, Department of Defense.

This new job, made possible under the newly-signed Reorganization Act, places emphasis—at long last—upon efficient management of weapons research. On this rests progress, and perhaps survival.

Research—a multi-billion dollar Defense Department endeavor this year—long has been without effective business management in the military establishment. Each service has managed its own program and costly duplication of effort and actual hardware often has been the result. Top-level decisions, particularly in space research—had they been made earlier and with greater wisdom—would have put this nation on top as the world's leader in astronautics, instead of relegating it to a secondary position.

It will take years to reorganize Defense Department R&D, but a lasting foundation can be quickly acted upon if the right man is appointed by the President. A record such as that demonstrated by Roy W. Johnson of the Advanced Research Projects Agency, should be the criteria for selection of a research and engineering chief.

Seldom has there been such quick decision-making by a DOD agency as ARPA has managed. This has been salutary, even though we haven't agreed wholeheartedly with some of the decisions. As a case in point, in the phenomenally short time of 12 days, ARPA executed orders to all branches of the services, making possible the early testing of our lunar probe project.

With the same speed and vigor, the agency, in just a few months, has developed an apparently sound and workable space program, where before there was virtually nothing. The credit goes to Johnson—whose contribution has been leadership.

Let's face the fact that the majority of the duties of the new Director, Research and Engineering, will be in space technology, and logical broadening of ARPA's basic function. The man selected must have this kind of background.

contents

news

Army R&D Looks to Major Prime Contractors
by William O. Miller .. 12
NACA Probes Vehicle Re-entry
by Donald E. Perry 14
Glennan Sees Management As NASA Key
m/r staff report 17
Nozzles in Production 18
Nose Cones: A Blunt Approach 24
Nautilus Guided by Missile System 28
WESCON To Highlight Three Special Sessions 30
Moon Probe Readied for Launch
by Raymond M. Nolan .. 32
Britain-Red China Enter Satellite Race
by Frank G. McGuire .. 33

columns

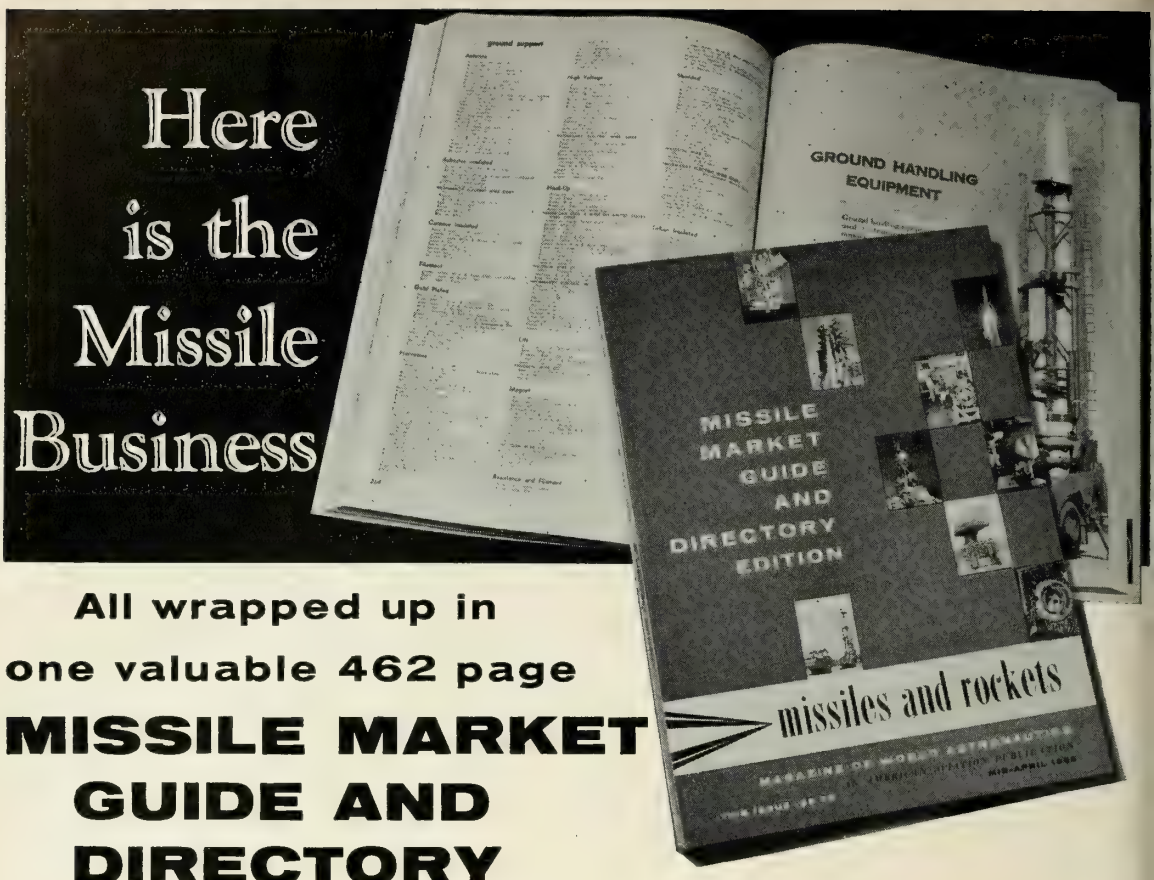
Industry Countdown 9
Washington Countdown 11
West Coast Industry 21
Propulsion Engineering 27

departments

Contract Awards 21
Missile People 34

cover

All scientific eyes are on the moon this week, as first attempts to reach that satellite move toward actuality at Cape Canaveral. (See page 32).



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INDUSTRY COUNTDOWN

GOVERNMENT

Passage by the House of a six-month extension of the Renegotiation Act should clear the way for Senate confirmation. The Senate traditionally declines to touch the bill until after House action . . . **DOD Secretary McElroy** reported looking for a "new face" for the post of Director of Research, Engineering . . . **The $39.6 billion DOD money bill** carries an amendment barring the use of 1959 funds for the construction of missile test facilities until existing installations are used to the "fullest practical" extent. The amendment grew from a controversy over reports that Holloman AFB facilities were being liquidated while duplicate facilities were being constructed by private contractors . . . **The Senate Committee on government operations** has reported favorably on a bill (S.3224) to increase from $1,000 to $2,500 the present open-market limitation for procurement without formal advertising and to provide other benefits to small business.

PROJECTS

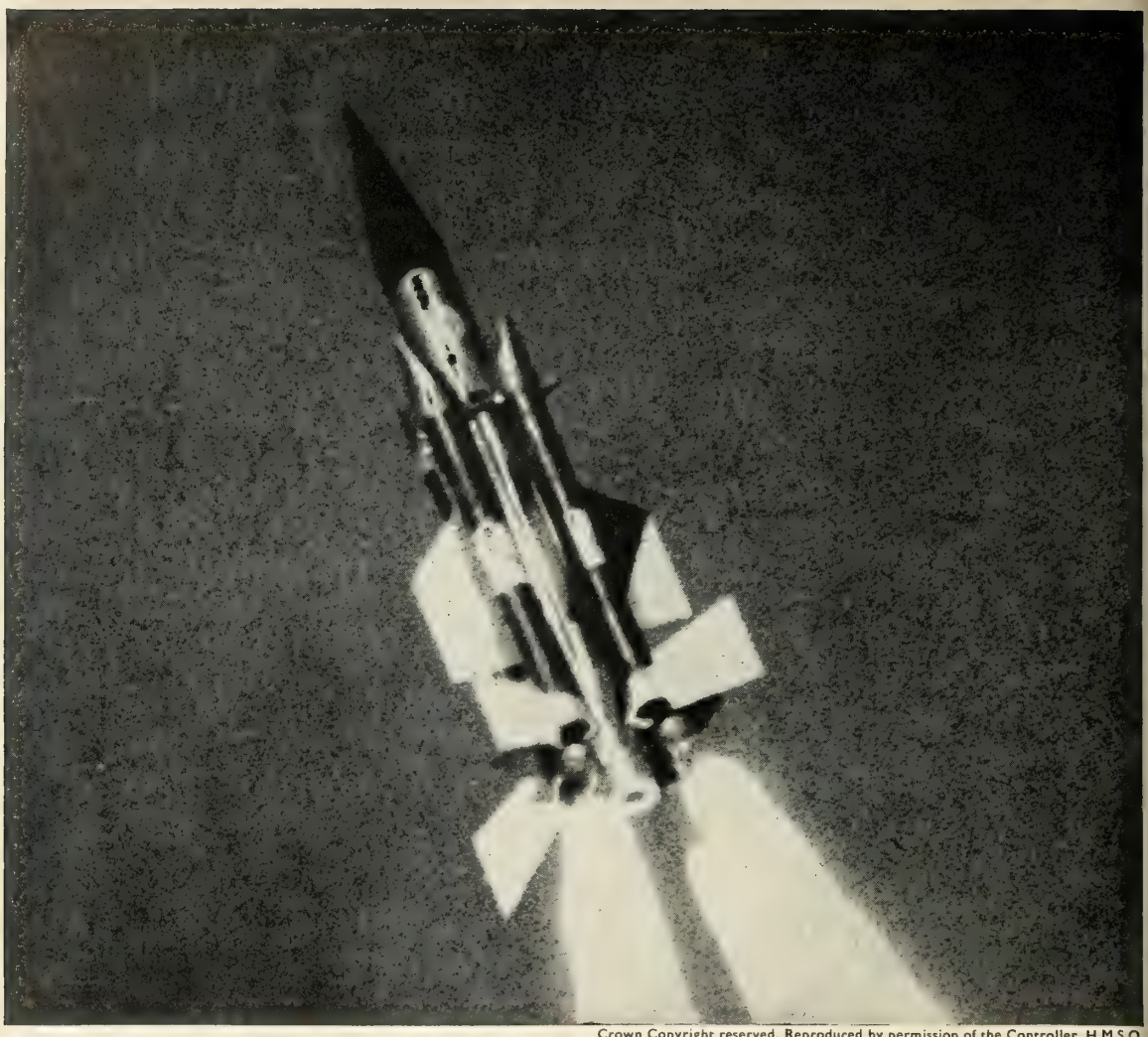
Nortronics Division of Northrop Aircraft working on a project for WADC involving "extremely advanced navigational techniques" . . . **General Electric's** J85 engine, to be used in the *Green Quail* decoy missile, passed its 15-hour preliminary flight rating test . . . **Use of heavy forgings** for big missiles being studied by AMC with some answers due in about six months . . . **Dr. Albert Hall,** Martin-Denver's head of *Titan* project, says industry must pour more of its own money back into research and not depend on the military when government policies are not clear . . . **Marquardt's XRJ59 ramjet engine,** slated for advanced version of the *Bomarc,* ran on test stand for equivalent time of three trips around the world at 70,000 ft. altitude . . . **Thiokol Chemical** planning to offer common stock to share-holders on basis of one new share for every 12 held . . . **Beech Aircraft Corp.** is running a sizeable advanced research program at its Boulder, Colo. division. Work concerns satellites, missiles and spacecraft . . . **The Army is studying** the feasibility of on-site firings of *Nike-Ajax* and *Nike-Hercules* missiles from several U.S. installations to demonstrate publicly how the systems operate. The announcement emphasized that warheads are "so constructed that they will explode only in flight" . . . **Chance Vought Aircraft** released figures on the growth of its electronics department; 20 men in 1951, 342 in 1956 and 400 in 1957. The company now manufactures about 5% of the electronics equipment going into its products.

MERGERS, EXPANSIONS, CHANGES

Chance Vought Aircraft to expedite anti-submarine warfare with group headed by Vice Admiral Harry Sanders (Ret.). Company intends to draw on past experience, including *Regulus* missiles . . . **Consolidated Electrodynamics Corp.** established an International Department within the existing Marketing Department . . . **Douglas Aircraft Company** to build one of world's highest speed wind tunnel centers, including trisonic, supersonic and hypersonic facilities . . . **Texas Instrument Inc.** opened a sales office at 317 Town and Country Village, Palo Alto, Calif. . . . **Sequoia Wire and Cable** acquired Hall-Scott Electronics, Burbank, for entry into the missile wire and cable field . . . **Temco Aircraft** to add 52,500 sq. ft. to the 100,000 sq. ft. Engineering Center, completed in 1957 at Garland, Texas . . . **The Calidyne Co. and Ling Electronics** joined forces in the manufacture, sales and service of vibration test systems . . . **Aeroquip Corp.** opened a new 10,000 sq. ft. plant in Dallas, Texas for extension of its hose and coupling capability . . . **American Potash & Chemical Corp.** enlarged its Washington office and assigned James S. Murray as director . . . **Olin Mathieson Corp.** joined two French firms and Aluminium Ltd. in setting up FRIA Compagnie Internationale pour la Production de l'Alumine, a $135 million corporation formed to develop bauxite deposits in French Guinea.

HOW'S BUSINESS?

Lear Inc. reported consolidated net earnings for the six months ending June 30 of $630,000, or 27 cents per share, compared with 14 cents per share for like period in 1957. Total net earnings for 1957 were $859,000 or 36 cents per share . . . **Sales totaling** $860,753,438—highest level ever attained for a first six-months period in the company's history—were reported by Boeing Airplane Company. Net earnings were $19,572,367, a 2.27% return on sales equivalent to $2.78 per share. Comparable figures for 1957 were $651,890,419 and $16,502,200 respectively . . . **Dow Chemical Company** had earnings in the year ending May 31 of $1.78 per share, down from $2.17 for the preceding year . . . **Giannini & Co.** report shows sales down to $5,296,190 for six months ending June 30 from $5,558,387 in 1957 but earnings of $203,139 or 58 cents per share unchanged. Present backlog totals $4,200,000 . . . **Fruehauf Trailer's** Missile Products division increased sales for first six months to $11,485,634 from $7,576,650 in first six months of 1957, while total company sales dropped $95,978,031 compared to $115,309,305 in like period of 1957 . . . **General Dynamics Corp.** increased sales for the quarter ending June 30 to $403,327,266 up from $400,953,042 in 1957's first quarter. However, net income fell to $10,179,601 from 1957's $10,937,347.



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NOW—THUNDERBIRDS FOR THE R.A.F

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WASHINGTON COUNTDOWN

• **MEN ARE KEY TO REORGANIZATION**—Now that the President has signed the Defense Department Reorganization bill (see p. 17) Washingtonians are watching closely for names of men who'll be appointed to fill key posts. It'll be these men that will get reorganization off the ground—or fail to make the program work. An example is the choice for Director of Research and Engineering. Assistant Secretary Paul Foot apparently isn't interested. ARPA Director Roy W. Johnson is being wooed, because of his proven management ability. Surprisingly, there are many actual applications from other men apparently eager to take on this mammoth headache.

• **JOINT EFFORT**—The Pentagon is convinced that the 1 to 1½-million-pound-thrust rocket engine will be a joint effort by the Defense Department and the new NASA—not exclusively a NASA job, as the House space committee was recently informed. Most important reason: the President has ordered the two-way effort, although this hasn't been announced officially, and probably won't be until he names the members of the important NASA space council. Second reason: NASA has a long way to go before it has the research capacity that will be necessary.

• **INCIDENTALLY**—The President has also ordered Defense department to take charge of space communications, navigation and meteorology. That seems to leave NASA with little control over anything.

• **REBUTTAL**—Apparently answering statements before the House Ways and Means committee—which last week extended the renegotiation act for another six months (m/r, August 11, page 16)—Navy issued a statement that aircraft overhaul, repair and modernization is being carried out "on a substantial scale" by private contractors. Said RAdm. Robert E. Dixon, chief of the Bureau of Aeronautics: Navy would like to take full advantage of private service shops, but dispersal of units to such shops could impair readiness of the fleet.

• **CANAVERAL STILL TOPS**—DOD has no plans to replace Canaveral or other existing test facilities with the huge Pacific Missile Range. The West Coast range will be used principally for testing operational weapons, and on occasion for special satellite launchings and other special projects. But that won't be started for about a year.

• **POLITICS IN MISSILES**—The upcoming political campaigns—already beginning to roll—will have a lot to do with missiles. You can read that easily into the by-play in committee hearings on the space bill, the budget and small-business problems. All sides of the political line are trying to make a record on the subject—some Congressmen by showing their willingness to approve much greater funds than have been asked; others by evincing interest in the problems of small business; the Administration by a show of attempt at careful money management. Right in the middle are the armed services, who can't satisfy anybody in this kind of an atmosphere. Since politics is not a game, but a way of life in Washington, you can expect to see constant investigations, criticisms—and perhaps even a little praise—from now until November.

• **WHO MOVES MISSILES?**—Many missile men may not know this—but the best qualified agency for moving missiles from factory to firing site are furniture movers, with their years of experience in attempting to preserve the housewife's pet china. And thereby hangs a tale of savings to Uncle Sam. Seems the furniture movers—who walk into a plant, package the missile and deliver it to the site—and Aircraft Industry Association's Transportation Committee got together recently, hammered out a new rate. Savings to U.S., on *Bomarc* alone (according to figures compiled by Boeing) will be at least $100,000 every six months.

Army R&D Looks To Major Primes

Responsibility For Quality and Delivery on Schedule Lies with Top Missile Contractors, says Gen. Trudeau

by William O. Miller

As missiles become more and more important in the arsenal of the Army, responsibility for developing the supporting research and development programs must be given to those capable of handling it.

So said Lt. Gen. A. G. Trudeau, in an interview with m/r last week.

He went on to emphasize the dependence of Army R&D on the major prime contractor, who must organize the efforts of hundreds or even thousands of sub-contractors, to make sure that schedules and production standards are met.

"There is absolutely no doubt that the Army, as well as all other military services, will increase its implementation of missiles of all types," explained the Army Chief of Research and Development.

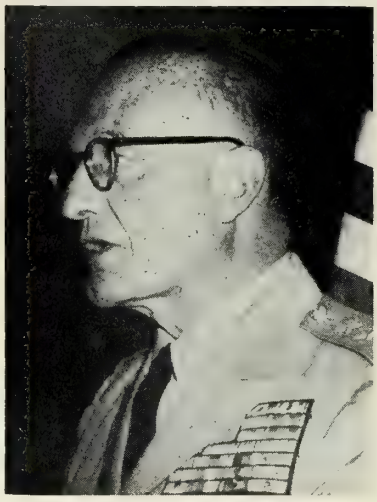
"However, if we are to have research of the scope and depth so vital to this highly complex area, we must have a massing of the scientific and technical skills of industry.

Gen. Trudeau said that many American industries, large and small, will play parts in the expanding effort. "But the responsibility for delivery on time of the quality components and materials by subcontractors must be assumed by the prime contractors," he added.

"This is the only way we can operate. We cannot get involved with the tremendous detail involved in making thousands of parts for a missile. We must decentralize this operation, holding the prime contractor responsible for the final job."

In this respect, the R&D chief was repeating the philosophy of the Army which calls for decentralization throughout its own R&D organization. Gen. Trudeau, for instance, as Chief of Army R&D, holds the chiefs of each Army technical service responsible for R&D operations in their respective areas.

At the same time, Gen. Trudeau did not discount the importance of the subcontractor. He pointed out that it takes only one malfunction of one part of a missile to cause a misfire. And the prime contractor must look to subcontractors to insure high standards in the thousands of different parts the subcontractors fabricate.



Lt. Gen. Arthur G. Trudeau

• **Congress criticizes**—The comments were made as the House Committee on Government Operations sent to lawmakers a report strongly critical of the research and development efforts within the Department of Defense, excepting the three individual military services.

Referring specifically to ARPA, the Director of Guided Missiles and the Assistant Secretary of Defense for Research and Engineering, the committee called for a reorganization by the Secretary of Defense within his office to integrate control under the Director of Research and Engineering, as provided by the Defense Department Reorganization Act (see also p. 5).

The report charged that "funds requested by executive officials for military research and development have been allowed to fall seriously, at the very time costs have risen sharply and weapons have become more and more complex."

The committee recommended a study as soon as possible by a firm of management consultants, and made the following specific recommendations:

(1) Reorganization to establish clear lines of authority running to the Director of Research and Engineering.

(2) Eliminate layers of review and minimize detailed reviews of project operations.

(3) DOD and Bureau of the Budget must recognize and carry out intention of Congress that R&D funds be made available so as to insure advancement of military programs at optimum rates. Fiscal operations should be geared to promote research and development, and not to hamper it, and DOD should review present methods of contracting for R&D services "with a view toward developing distinctive contract procedures and terms suitable for R&D rather than handling such contracts in the same manner as those for production and procurement of material and supplies."

(4) The Assistant Secretary of Defense (R&D) or his successor should participate actively in all stages of budgetary process and have a small budget under his direct control to expend in positive basic or applied research activity.

(5) In the new organization, the Secretary of Defense should insure establishment of the military R&D program on the basis of the nation's need, in a framework of appropriations and fiscal controls which will advance research progress rather than impede it.

(6) A definite policy should be established in DOD to insure orderly retrenchment of scientific projects when retrenchment is unavoidable; and approved projects making good progress should not be suddenly terminated. Full use should be made, when possible, of highly skilled technical teams and costly facilities, rather than allowing them to break up because of "shortsighted and poor planning, managing and funding."

Concluding recommendations included need for recognition of the fact that "wise management of research and early development may require parallel efforts in order to reach the best choices in weaponry." This policy, the committee continued, would have to be worked out so that the desired end be clearly understood.

The report said that "undoubtedly inter-service rivalries and confusion of roles and missions" brought on unnecessary and expensive duplication up to and including production. However, the report said "there is every reason to engage in as much research as possible, even to encourage directed competition along parallel lines of endeavor."

The committee urged strong discipline in decision-making at the proper time. "Each stage from research through development calls for an appraisal and a decision which makes for improvement to determine whether a research project merits continuation into the development stage, and when it should

move into the production stage."

"Public opinion and Congress must insist," the report said, "that the President authorize the Department of Defense to fund and carry out the type and size of military research and development program those directly charged with our military affairs believe is necessary for the security of our nation."

• **Army R&D**—Under the Secretary of the Army and his Chief of Research and Development (Dr. William H. Martin) Army research and development is headed by Gen. Trudeau. He is responsible for design of new items and provisions of developmental and design models for test and evaluation.

The Assistant Secretary of the Army for Logistics is involved in R&D insofar as contracting for development, provision of funds in support of the program, and the functions and operations of the Army's seven technical services.

All general staff agencies have an interest in R&D and are represented on the Army R&D Review Board.

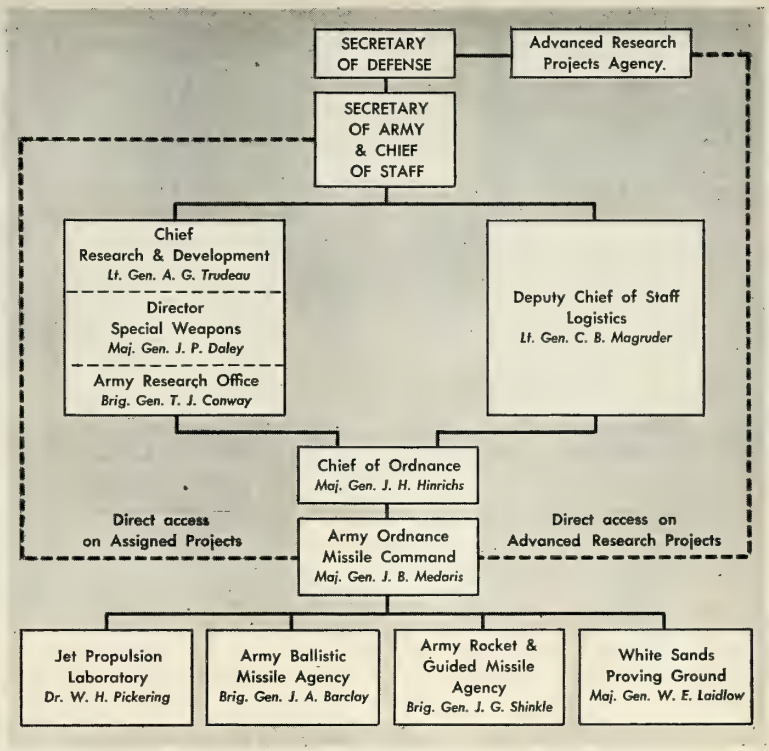
• **Wide spectrum**—The responsibility of the Chief of Research and Development for the Army covers a wide spectrum and his activities are closely coordinated with all Army Staff elements. His duties cover planning, coordinating, directing and supervising all research and development.

As indicated by the chart, Gen. Trudeau deals directly with the technical staffs and services. On the other hand, personnel and money for research and development activities of the technical services are allotted to the Army Deputy Chief of Staff for Logistics, Lt. Gen. C. B. Magruder. Gen. Magruder, in close cooperation with Gen. Trudeau, makes such funds available to the technical services at the request of the Chief of R&D.

The Advanced Research Projects Agency of the Department of Defense has direct access to the Army Ordnance Missile Command on assigned special priority projects, such as satellites and lunar probes.

The one other exception to normal chain of command channeling is a two-way channel between the Secretary of the Army and his Chief of Staff and the Army Ordnance Missile Command on assigned special priority projects.

The Chief of Ordnance, through whom the Deputy Chief of Staff for Logistics and the Chief of Research and Development normally have access to the Army Ordnance Missile Command and its divisions, is but one of the Army's seven technical services. The others are: transportation corps, medical corps, Quartermaster corps, Signal corps, and Chemical corps.



BASIC ORGANIZATION of Army's Research and Development Offices.

• **ARO setup**—Directly under Gen. Trudeau, the Army Research Office was established in March of this year. Its mission, under Brig. Gen. T. J. Conway, is to promote and coordinate Army research effort in physical, engineering, geophysical, biological, medical and the social sciences. In addition, it coordinates the efforts of the technical services which direct actual research projects in their individual fields.

Contractors interested in submitting proposals in the research and development fields normally make contact first with a field agency of the appropriate technical service. For instance, a firm interested in missile R&D would contact one of the 14 Ordnance Districts.

To assist prospective contractors, Army R&D has prepared a booklet titled "CONTRACTORS GUIDE," available on request to the Technical Liaison Office, Office of the Chief of Research and Development, Department of the Army, Washington 25, D.C.

General Trudeau said that he has a number of recommendations and proposals he will submit to the Secretary of the Army for transmittal to the Secretary of Defense, when called for, as the reorganization of the Department of Defense progresses. He said there are a number of reorganizational changes being considered for the Army research and development program, but that nothing can be done until the Department of Defense outlines its own plans.

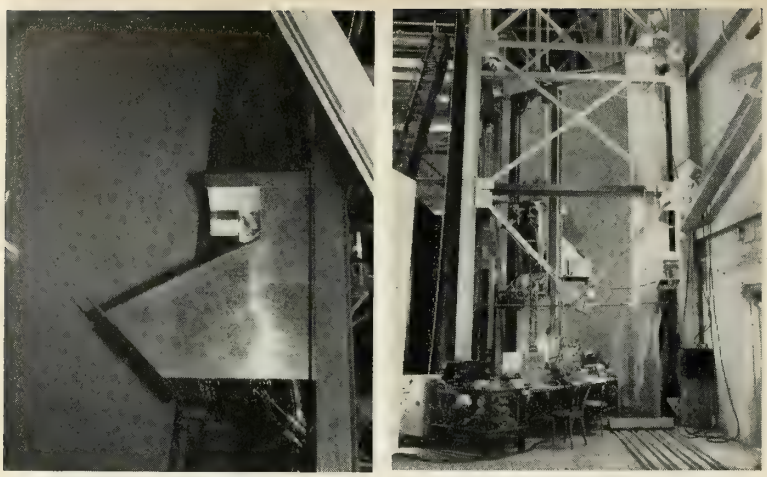
DOD Reorganization Law, Effects Seen Gradual

The controversial Defense Reorganization Act became law last week when the President signed the bill which included a number of compromises and fell short of what the Administration had sought.

The act: places directly under the Secretary of Defense and the Joint Chiefs of Staff the direction of strategic planning and the unified combat commands; it does call for an increase in the working agency of the JCOS; and it does provide for the creation of a new Director of Defense Research-Engineering.

The act does not, as sought by the Administration: give the Secretary of Defense greater control over military appropriations; provide some of the powers wanted for the Joint Staff; and it does not give to the executive department some of the control Congress has of Pentagon policymaking.

In any event, implementation of the act will be gradual, most observers think. It will take six to 12 months before real effects are felt.



RELATIVELY INEXPENSIVE NACA motion simulator in operation at Langley Field, Va., provides damping and stability testing data for space vehicle re-entry.

NACA Probes Vehicle Re-entry

Time-Cycle for Manned Flight Cut At Small Cost

by Donald E. Perry

LANGLEY FIELD, VA.—Motion simulator tests, started two years ago at NACA's Flight Research Laboratory here, have shortened the time cycle for the National Aeronautics and Space Administration's manned space flight program, which begins in earnest this year with a $30 million budget.

And, amazingly enough, simulator research has cost only a few thousand dollars, thanks to the ingenuity of NACA personnel.

By using an *Atlas* booster, NASA scientists are confident they can put a manned vehicle in orbit within two years. Payload weight would be on the order of 2,100 or 2,200 pounds; and during entry the vehicle would decelerate at 10 g's, well within the endurance capability of the pilot.

Orbit would be at approximately 120 nautical miles and the vehicle would be stabilized to prevent tumbling. Initial flights would be limited to just a few passes around the earth, facilitating recovery. Present plans call for using a parachute at 25,000 feet altitude, which would bring the vehicle and its passenger gently back to earth.

Within the next 11 months, NASA will spend $6.5 million for development and construction of model and full-scale capsules for centrifuge, static and flight experiments. Instrumentation for models and full-scale flight capsules will cost another $4 million. *Atlas* boosters for five model and two capsule-scale flights, some containing small animals, will cost at least another $19.5 million.

A vital part of this program's success depends on the work of the Flight Research Laboratory. Research is now underway to determine whether it is possible to stabilize a simulator for the small deviations a pilot will encounter during re-entry, taking into consideration that large deviations should never arise because of built-in design characteristics of the vehicle. Studies also are being made on the effect of these motions on the pilot.

Langley tests have shown that if the right shape is chosen for the space vehicle, its motion will be well damped. The frequency of the damping motion should be one cycle per second, within the airplane order of damping frequency—and should not become troublesome to the pilot. (Damping is the diminishing amplitude of an oscillation, due to friction or similar cause.)

In order to use simulators properly, NASA must determine first what characteristics should be built into them, for a simulator's usefulness is measured in terms of safety and economy. The safety aspect is obvious. In space flight, the penalty for equipment failure, pilot error, or wrong choice would be catastrophic. Economically, 10 or 15 satellite launchings to achieve results possible with simulators would be staggering in cost.

At Langley, research engineers Porter Brown and Harold I. Johnson, believe that motion is one of the most important requirements for a space flight simulator.

The problem of supplying a space vehicle pilot with a "feel" force will be no different in space than in air, NACA said, and electronics should easily provide artificial stabilization of control forces.

In space, the vehicle will be sluggish like a bomber, and the pilot will have to provide a force of 200 to 400 pounds for each inch of control stick motion. Langley has acquired data as high as 250 pounds for each inch of stick motion.

Johson and Brown have built and instrumented a NAP Chair—Normal Acceleration and Pitch—to acquire entry data. It is capable of duplicating the vertical and pitching motions of space vehicles within the limits of disturbances likely to be encountered.

A chair holding the pilot moves on eight foot rails and can furnish up to two G's. The pilot must control his descent motion within plus or minus five feet. A slide projector mounted to the chair projects a sighting image on a screen in front of the pilot. A small red ball strung on fine wires is his target.

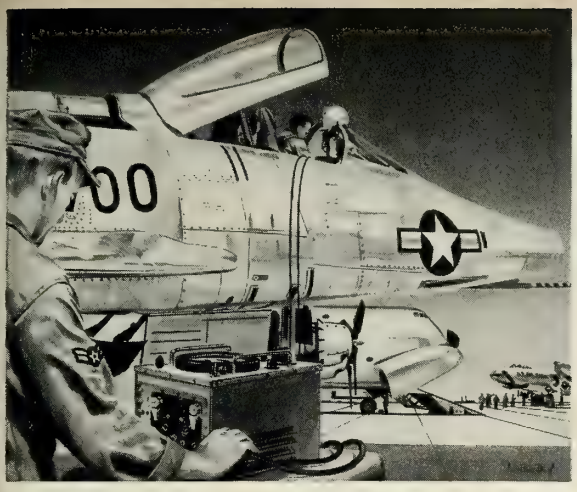
Total cost of the simulator is a little over $10,000. Brown and Johnson estimate they saved $30,000 in analog equipment by designing an electro-mechanical system.

• **All instrumentation** was designed specifically by NASA technicians. An EPT unit (Evens per unit of time) gives a quantitative measure of the pilot's performance in chasing the ball, with or without damping effects. A skin resistance unit tests physiological reactions of the pilot when he is faced with awkward control situations and high G forces.

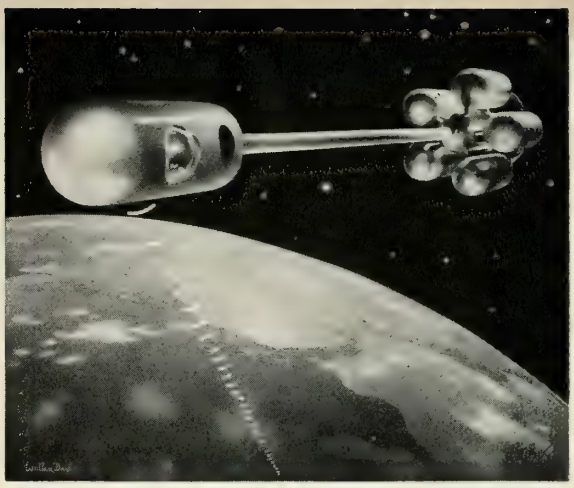
The nerve center of the system is a differential transformer that furnishes dynamic motions. When the pilot moves his stick, this in turn actuates the rotor of an identical differential transformer. One differential transformer follows the other's position. The dynamics of motion are determined on a small disk, the intertia of which simulates the inertia of the vehicles XY axis.

On the disk are various electrical hysteresis dampers, which simulate the aerodynamic dampening of the vehicle. The strength, or tendency of the differential transformers to remain synchronized, is determined by applied voltage. This tendency simulates the stability of the vehicle. Movements of the disk are synonymous to the angle of attack and normal acceleration.

Further research should provide the answers to what types of control stick —center, sidearms, hydraulics—the pilot should have. Extension of the simulator's track to 60 feet can give additional G force, and provide data on whether a pilot could regain control if lost.



TEST INSTRUMENTS Bulova's rugged Tachometer Tester for all jet and reciprocating systems meets MIL-T-945A requirements—is accurate to 0.1% with engines on or off. Simple to operate and maintain, this field unit also serves in maintenance depots. Precise Bulova testers include the dual purpose Torqmeter—a dynamometer or calibrated torque source



RECONNAISSANCE SYSTEMS Bulova-developed miniaturized sensor packages, geared to specific tactical missions, feed combat surveillance data to Bulova analysis and display systems. Camera, infra-red, TV and radar techniques, combined and integrated, aid decision-making on land and in space. Satellite applications? Unlimited!

Bulova's capability helps to solve today's most challenging problems

To conceive, develop and manufacture a broad range of advanced electronic and electro-mechanical devices...this is the Bulova capability.

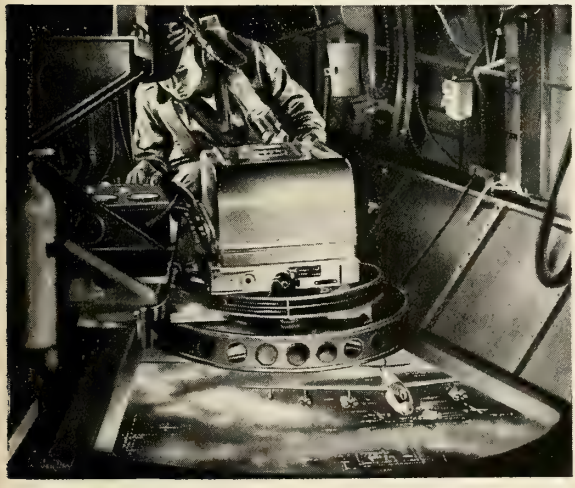
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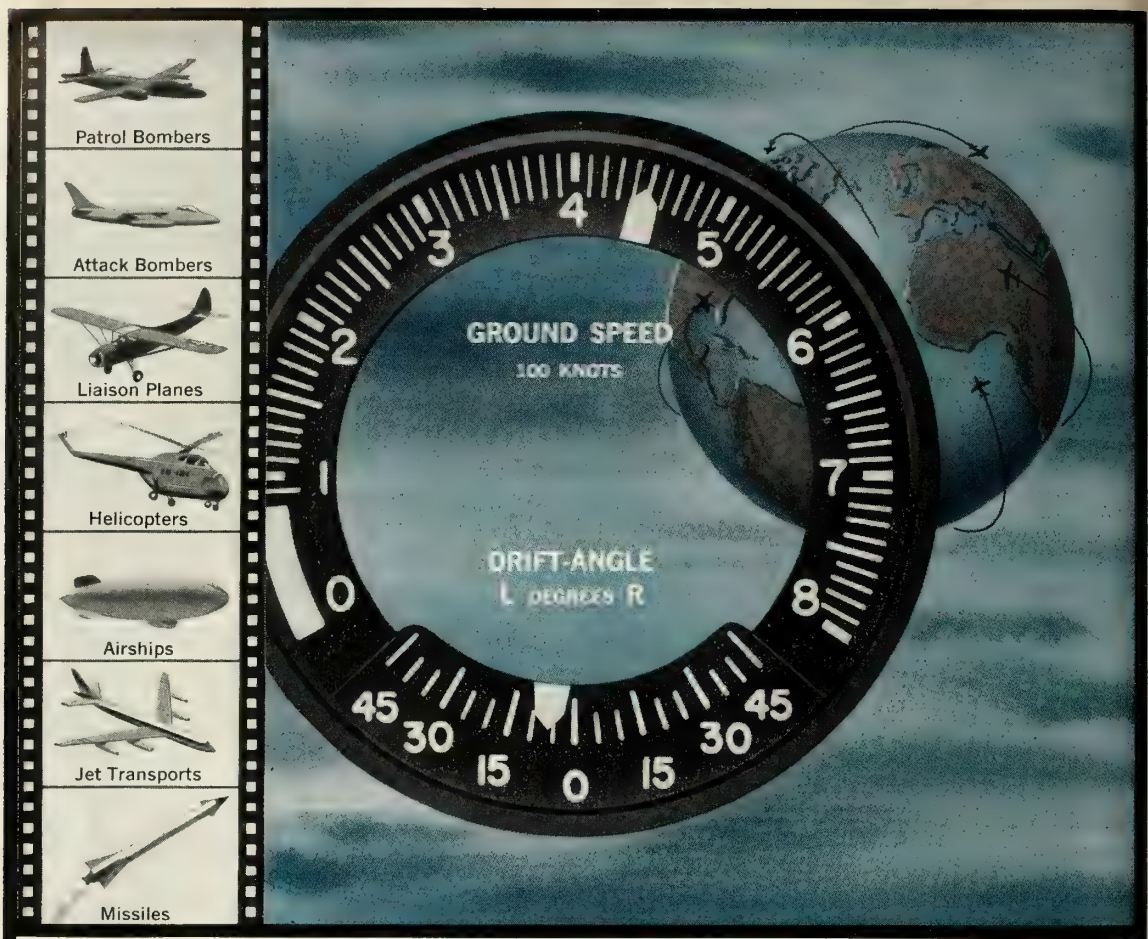
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INFRA-RED COMPONENTS Bulova's advanced IR projects include mosaic cells that will automatically filter out unwanted wave lengths and picture targets clearly against any background. Bulova infra-red R&D covers lead selenide and lead sulfide cells, missile seeker cells, reticles, filters and thermistor bolometers...for defense and industry.



INFRA-RED SYSTEMS Bulova's IR illuminators put unseen spotlights on night objectives. Bulova's development capability extends to fire control systems that detect, track and automatically lock on target. Designed for accuracy and simplicity, these high resolution units will serve our nation's land, sea and air forces.



WHY RYAN CONTINUOUS WAVE RADAR IS BEST FOR DOPPLER NAVIGATION

Through its pioneering work with the Navy and Army, Ryan has demonstrated that continuous wave radar is the best Doppler navigation system for every military and commercial application.

Ryan RANAV* systems are the only CW Doppler navigators in production. They have major advantages for aircraft navigation, ground speed measurement, missile guidance, and helicopter hovering. For example, RANAV is:

LIGHTEST—Ryan Doppler navigators are lightest, saving many precious pounds of weight, because CW radar requires less power for comparable performance and eliminates the need for many components required by pulse radars. RANAV also features a unique lightweight *non-gimballing* antenna system.

SIMPLEST—RANAV requires no IF (intermediate frequency) amplifiers or automatic frequency control circuits. Only one microwave generator is used and the systems have less tubes and components.

MOST COMPACT—Inherent simplicity of CW radar systems plus the ingenuity of RANAV design has enabled Ryan to take most advantage of subminiaturization and transistorization, creating compact systems with advanced modular units and etched circuitry.

MOST RELIABLE—RANAV continuous wave automatic navigators are most reliable because they are simple, rugged, and completely transistorized. RANAV also uses a long-life transmitter and it features a foolproof, non-wiggly (fixed) antenna with no moving parts and no adjustments.

*TRADE MARK

RYAN BUILDS BETTER

ELECTRONICS DIVISION

Ryan Aeronautical Company, San Diego, Calif.

Glennan Sees Management As NASA Key

an m/r staff report

CLEVELAND—T. Keith Glennan, nominated by President Eisenhower as administrator of the new National Aeronautics and Space Administration, admits he is not a space man by training, but basically an administrator of scientific research. The 52-year-old scientist-educator has been president of Case Institute of Technology since 1947.

The Senate conducted hearings last week on confirming Dr. Glennan and Dr. Hugh L. Dryden, present director of the National Advisory Committee for Aeronautics, who was nominated by the President as Deputy Administrator. Dr. Dryden, 60, is a Democrat; Glennan, a Republican. The administrative post pays $22,500 annually; the deputy administrative post, $21,500 annually. If confirmed, Glennan plans to take over his new duties about September 1.

Commenting in an exclusive interview with m/r, Glennan said he would formulate his ideas when he takes over the job. However, he believes absorption of NACA by NASA will provide the new space agency with an excellent base of scientific and technical personnel on which to build.

"The line between military and civilian exploration of space is an unproven one," he commented, "but I am sure we can expect excellent cooperation from both."

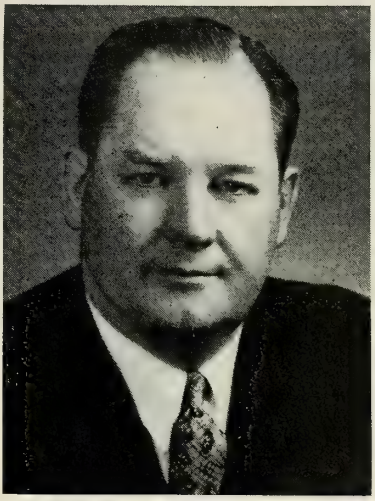
• **Soviet vs. U.S. progress**—Glennan said he is impressed by Russian scientific education. However, he said he deplores any criticism of American progress in space exploration since the time the Russians put the first satellite into orbit last fall.

"We've done a great deal, but we can't do it overnight," he pointed out.

Glennan has in mind a 15-day trip earlier this summer, when he visited Soviet colleges and universities. He said the Russians are making better use of the capitalist incentive system to encourage education than the Americans.

"They have developed a demand for education because it pays off," he remarked. He emphasized that a student "is paid according to the quality of his work," and there are three to six applicants for every scholarship.

• **Early days**—Born in Enderlin, N.D., Glennan grew up in Eau Claire, Wisconsin, and enrolled in an electrical engineering course at Yale. At midyear, he told the college board he was interested in people as well as machines, and broadened his courses to include liberal arts. He graduated cum laude with a degree in electrical engineering.





NEW SPACE BOSSES—Dr. T. Keith Glennan (left) will be administrator, and Dr. Hugh Dryden (right) deputy administrator of the new federal space agency.

Glennan is the son of a railroad dispatcher, and worked his way through college. At $35 a week, he spent two years in Europe supervising installation sound systems for Paramount, and then went to Hollywood as a studio manager. He later had a similar job at Goldwyn Studios. In World War II, Glennan was administrator and later director of the Navy's Underwater Sound Laboratory at New London, Conn. From there, he advanced to research and development work at the Ansco Corp., Binghamton, N.Y.

• **Progress of Case**—Glennan has built Case into one of the top-ranking engineering schools in the nation. During his eleven-year administration, Case was transformed from a primarily local institution into a school that Dr. Edward Teller ranked with the first four engineering schools in the nation.

During his tenure as president, Glennan spent two years as a member of the Atomic Energy Commission. His work has earned him various honors, including the medal for merit, the highest government award given a civilian. He also has been awarded honorary degrees in science and engineering from five universities and technical institutes.

Glennan is a member of the board of the National Science Foundation; chairman of the board of IDA (Institute for Defense Analysis); a member of the board of directors, Council on Financial Aid to Education; and a member of the General Advisory Committee of the AEC.

IDA holds a defense department contract for supplying scientific personnel. Advanced Research Projects Agency is staffed principally by IDA scientists. Presumably, Glennan will drop his IDA affiliation if confirmed.

Among his business affiliations, Glennan is a member of the board of the Cleveland Electric Illuminating Company; the Clevite Corporation; Standard Oil (Ohio); and the Harris-Intertype Corporation.

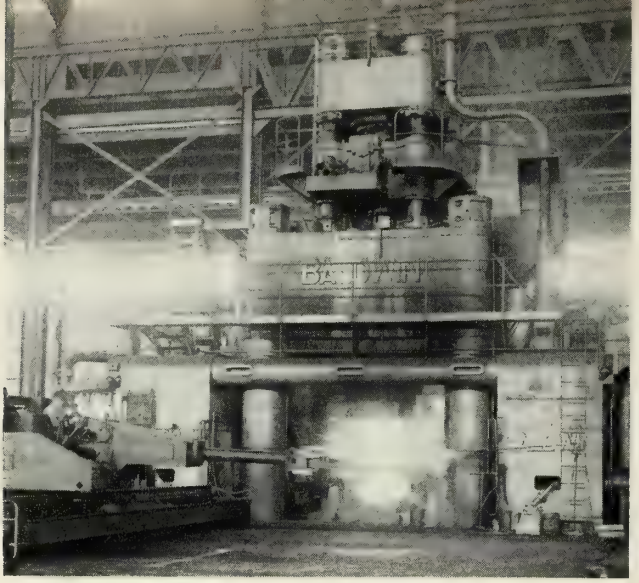
• **Dryden's qualifications**—Dr. Hugh Latimer Dryden, named as deputy administrator of NASA, is known as a conservative visionary.

Dryden was introduced to space by the late Dr. Joseph S. Ames, who later became chairman of NACA. At Johns Hopkins University Graduate School, Dryden was persuaded by Dr. Ames to undertake a study of fluid dynamics at the Bureau of Standards. In 1920, he was promoted to head the Bureau's aerodynamics section.

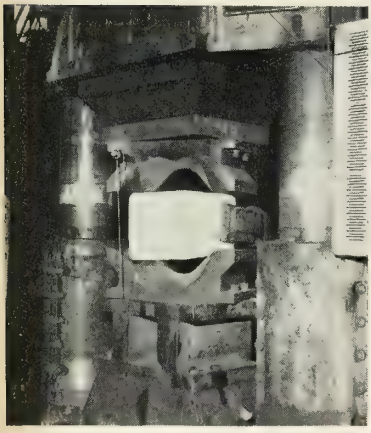
The Armed Forces used his services during World War II, as advisor on aeronautic and guided missile problems. In 1948, he received the Presidential Certificate of Merit.

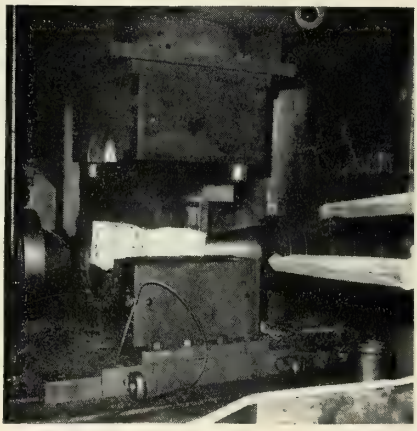
Toward the end of the war, as Deputy Scientific Director of the AAF Scientific Advisory Group, Dryden traveled through western Europe to study foreign aeronautic and missile weapon development. This work won him the Army's Medal of Freedom.

In 1947, Dryden went to work for NACA as Director of Aeronautical Research. Two years later, he was named director of the agency, a position he now holds.



Nozzles in Production



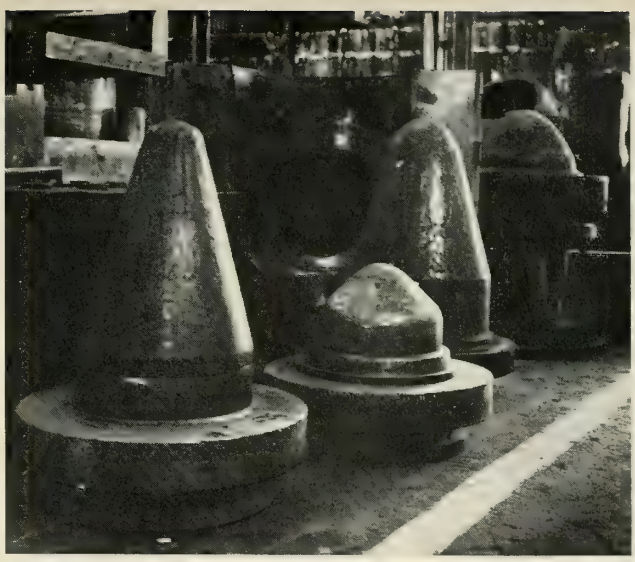


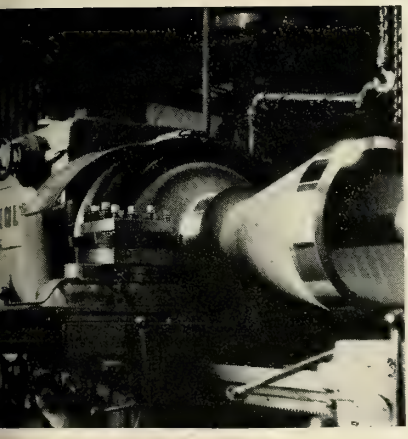


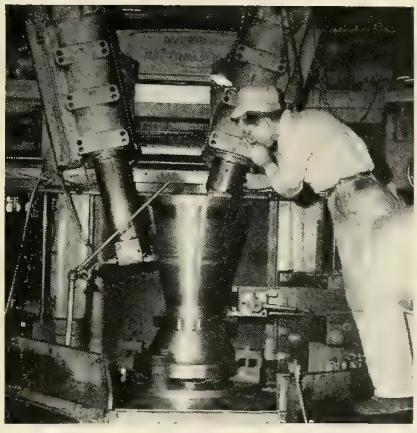


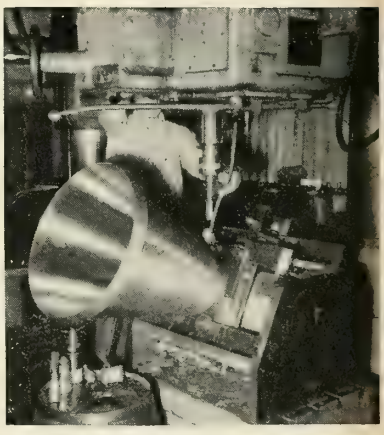
FORGING AND MACHINING are two of the primary operations in missile production, playing a proportionately bigger role than they normally do in aircraft manufacture. The pictures on these pages show the step-by-step life history of the birth of an *Honest John* nozzle. The only major step omitted is heat-treating. All work being done is at Cameron Iron Works, Houston, Texas. Cameron, basically a manufacturer of high-pressure, high-flow rate valves and fittings for the oilfield industry, is becoming progressively interested in missiles. Aside from considerable forging and machining on parts such as these nozzles, Cameron also has a special Navy-owned facility for making complete *Terrier* motor-casing assemblies.

THE GIANT PRESS used in forging these pieces is unique. With an 11,000-ton vertical ram and two 6,000-ton side rams, it forges the complex nozzle shape in one operation from billets requiring a minimum of pre-preparation. When removed from the press, only a small center plug of metal has to be punched out before the forging is ready for rough and finish machining. Note that for machining, both lathes and vertical boring mills are used. The tactical Douglas Aircraft *Honest John* ballistic missile is one of our higher production rate missiles. (Right) Press dies for forging **the nozzles.**



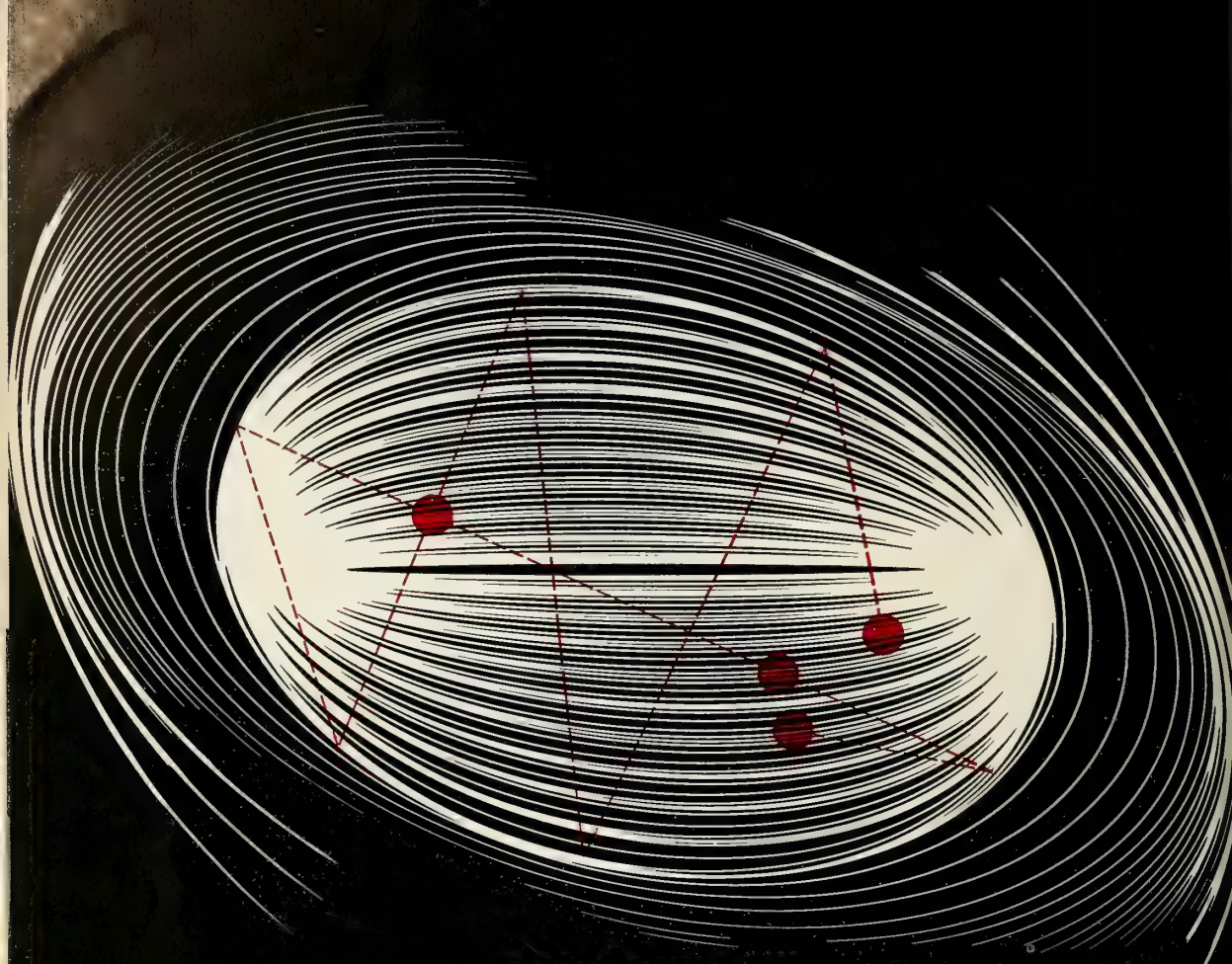






HONEST JOHN has atomic capabilities, is part of a completely air-transportable weapons system, and is now deployed with our forces both here and abroad. It is an Army development, and is supplemented in its role by *Little John* and *Lacrosse*. Here, a worn die-mold is being rebuilt, first by laying in metal with a welding torch, and then finish machining to size. The strip of pictures (above) shows the various steps in preforming, pressing, rough and finish machining and tapping. These nozzles (right) have now been heat treated, trued up, and are now ready to be crated for shipping. Though high precision is required in volume production, there is nothing essentially "tricky" about making nozzles this way.





SAGE SETS AN ELECTRONIC "BEAR TRAP"

BURROUGHS ELECTRONIC DATA PROCESSING EQUIPMENT STANDS WATCH FOR OUR CONTINENTAL AIR DEFENSE.

Problems of the awesome speeds and scope that confront our military defense systems can only be solved by the quick and uncanny accuracies of electronic computation, such as is found in our Semi-Automatic Ground Environment—SAGE, which is now becoming operational! As a result Burroughs radar data processing equipment fills important posts all along our peripheral continental approaches.

This major U. S. Air Force contract is one example of the widespread confidence in Burroughs Corporation's 70-year background of reliability and capability. It demonstrates Burroughs' new breadth in the development of electronic equipment and its continuing competence from research to final installation.

Burroughs Corporation

"NEW DIMENSIONS / in electronics and data processing systems"



west coast industry

by Fred S. Hunter

Small firms in the southern California area seem to be making headway in their campaign to obtain set-asides for small business on contracts let through the Air Force's Ballistic Missile Office. Defense Department procurement regulations spell out procedures for these set-asides for the benefit of small bidders, but up to now they have had little, if any, application in the ballistic missile program.

For one thing, the projects were classified and small firms had no way of finding out what work might be within their capabilities. Now they've discovered that the ballistic missile program is one of the most promising for their type of work. In response to their negotiations, Maj. Gen. Ben Funk, BMO chief, recently added a small business specialist to his staff to administer a set-asides program and to assist small shops in obtaining military work.

Rohr Aircraft Corp., which, with a payroll in excess of 15,000 employees has the distinction of being the biggest subcontractor in the aircraft industry, has moved into the missile field with an order from North American Aviation for support pylons for the GAM-77 (*Hound Dog*) air-to-surface missile. These pylons are to be mounted to the underside of Boeing B-52s. They'll be produced at Rohr's Riverside plant. The material will be a metal bond structure, selected because of its ability to "damp" vibration close to engines. During buildup, Rohr will supply tooling engineering service to NAA.

In a couple of years, 50% of the Douglas Aircraft Co.'s total volume of business will be in missiles, says Donald W. Douglas, Jr. With three major production articles—the IRBM *Thor,* the ground-to-air *Nike* and the air-to-air *Ding Dong*—Douglas already is the nation's biggest missile producer. The *Thor* is assembled at the home plant in Santa Monica; the *Nike* at Charlotte, N.C.; and the *Ding Dong* at Sacramento.

Interim facilities for the WS-117L reconnaissance satellite being developed for the Air Force by Lockheed, are scheduled for completion at Cooke Air Force Base September 4. The facilities include launch pad, gantry and instrument buildings. Basic technical equipment will be ready for preliminary systems testing in October. The WS-117L, it is reported, will be fired into orbit by an *Atlas* ICBM and circle the earth from pole to pole.

With a backlog of military orders in excess of $14 million, Packard-Bell is negotiating for a 100-acre electronics park in southern California to be used by its technical products division . . . **Hughes Aircraft Co.** is slated to move its semi-conductor division to Newport Beach into the plant formerly occupied by the Helipot division of Beckman Instruments . . . **Varian Associates** at Palo Alto are working on components for a magnetometer to be used in future satellites.

contract awards

LAST MINUTE AWARDS

Convair Astronautics Division of General Dynamics Corp. gave $100,000 to R/S Electronics Corp., Regan Industries, Inc., for manufacturing intermediate frequency amplifiers for use in the *Atlas* intercontinental ballistic missile.

Benrus Watch Company received $3-million for the manufacture of air-to-air guided missile launchers for the *Sidewinder* and *Sparrow* programs, and for electronic equipment to be utilized in the important air traffic safety program . . .

The Missile Division of North American Aviation, Downey, Calif., has awarded a contract to the Metal Products Division of Koppers Co., Inc., Baltimore, Md., for the design and construction of seven portable silencers.

ARMY

By Philadelphia Ordnance District:

Western Electric Co., Inc. received $33,900 for spare parts (*Nike* & M33 systems).

Air Products, Inc. received $2,179,200 for semi-trailer, liquid oxygen.

Leeds and Northrop Co. received $30,565 for recorder.

Princeton University received $35,000 for problems connected with differentiable and complex analytic structures.

Western Electric Co., Inc. received 7 contracts totalling $703,027 for *Nike* spare parts and components.

Douglas Aircraft Co., Inc. received 3 contracts totalling $185,539 for *Nike* spare parts and components.

University of Maryland received $53,000 for study of cosmic ray attitude sensing device.

The Franklin Institute of the State of Pennsylvania received $27,750 for emission of electrons from metals and induction of electrical conduction in crystals resulting from electron bombardment.

Atlas Powder Co. received $29,953 for design, and development of miniaturized hermetically sealed squib switches.

Douglas Aircraft Co., Inc., received 7 contracts totalling $895,872 for *Nike* spare parts and components.

Western Electric Co., Inc., received 7 contracts totalling $854,460 for *Nike* spare parts and components.

Applied Science Corp. of Princeton received $51,983 for study of telemetry data analysis technique.

RCA Service Co., Radio Corp. of America received $1,500,000 for multi-purpose missile system test equipment.

The Johns Hopkins University received $100,000 for research on the vulnerability of aircraft and missiles.

Duke University received $70,500 for basic research program of the ordnance corps and the mathematics research program of the Dept. of the Army.

By Signal Supply Agency:

Cutler-Hammer, Inc., Airborne Instruments Laboratory Div., Mineola, N.Y., received $95,700 for research and development work on microwave reactance amplifiers and harmonic generators for 12 months.

General Electric Co., Owensboro, Kentucky, received $476,640 for research and development for 3 years on subminiature electron tubes.

Hughes Aircraft Co., Cutler City, Calif., received $99,994 for research and development work to continue the study of atomic and spin resonances for microwave generation and amplification.

Lansdale Tube Co., Lansdale, Pa. received $59,521 for research and deveiopment work on silicon PNP alloy junction transistors.

Linfield Research Institute, McMinnville, Oregon, received $49,820 for research work on electrolytic mecromachine techniques of refractory metals for use in field mission electron devices.

Radio Corp. of America, Moorestown, N.J., received $47,372 for research study and investigation of the wind response characteristics and the estimated wind deviation of the *Little John* rocket.

By Purchasing and Contracting office, Research and Development Labs:



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. . . contracts

American Optical Co., Buffalo, N.Y. received $49,610 for design and development of infrared binoculars.

General Mills, Inc., Minneapolis, Minn., received $94,892 for study, preliminary design of equipments and development of methods for automatic tracking theodolite.

Southwest Research Institute, San Antonio, Texas, received $68,670 for magnetic anomaly studies.

General Electric Co. Philadelphia, Pa., received $78,533 for study, preliminary design of equipments and development of methods for automatic tracking theodolite.

By Engineer Division, New England Corps of Engineers:

Kirkland Construction Co., Inc. Cambridge, Mass., received $1,480,794 for construction of missile master facilities.

Paino-La Cava Co. Inc., Lexington, Mass., received $1,691,615 for construction of additional pavements and minor structures for *Nike* batteries.

AIR FORCE

By Cmdr., HQ AMC, Wright-Patterson AFB:

Sperry Gyroscope Co., Sperry-Rand Corp., received $1,018,215 for APW-22 command guidance transponder sets, spare parts and reports for XQ-4A drones.

Avionics Div., Bell Aircraft Corp., received $500,000 for design, development of high-performance inertial navigator—the Hipernas II—and applicable spare parts, technical reports and engineering data.

Associated Missile Products Co., American Machine & Foundry Co., received $1,629,911 for AN/GPS-T4 radar target simulator trainer, engineering data and maintenance data.

David Clark Co., Inc., received $199,638 for full pressure altitude suits.

The Four Wheel Drive Auto Co. received $919,525 for prime mover for the TM 76A missile system. Semiconductor Div., Radio Corp. of America, received $100,000 for development of high temperature, semiconductor devices; $400,000 for production refinement of four types of semiconductor devices, transistors and diodes for engines controls for missiles, space vehicles.

American Machine & Foundry Co. received $48,714 for research services and reports on development of a set of physical vulnerability probability computers.

Air Mod Corp. received $528,297 for services and materials for conversion of USAF STRATCOMSYS centers from neutral to polar signaling.

(Leonard Anderson Associates, Inc. received $28,020 for production of motion picture entitled "Force for Space."

General Ceramics Corp. received $63,381 for development and manufacturing methods for production of miniaturized high voltage transformer terminal.

Applied Science Laboratories, Inc. received $154,936 for experimental hydrocarbon fuels, to be used in full-scale and engine tests etc.

A/C Spark Plug Div., General Motors Corp., received $1,162,658 for product improvement of the 107 inertial floated gyroscope to increasing its reliability and performance.

Electronic Systems Div., Sylvania Electric Products Inc., received $346,572 for ECM attachments to the AN/GPS-T2 radar simulator.

Patterson-Moos Div. of Universal Winding Co. received $98,053 for infrared gas detection cell.

Thiokol Chemical Corp., Utah Div., received $1,008,475 for M-16E-1 rocket engines in support of *Matador* missile program.

By Cambridge Research Center, ARDC:

The President and Directors of Georgetown College, Washington, D.C. received $45,000 for research directed toward application of photographic plates of artificial earth satellites for geodetic purposes.

Weston College, Weston, Mass., received $74,000 for research directed toward experimental determinations of ionospheric characteristics using satellite radio transmission.

Massachusetts Institute of Technology, Cambridge, Mass., received $150,000 for theoretical and experimental research in thermoelectricity.

Columbia University, New York, N.Y., received $30,000 for experimental and theoretical study of elastic wave propagation.

By HQ, Middletown Air Materiel Area:

Gas Industries Inc., Allentown, Pa., received $1,591,296 for liquid oxygen and liquid nitrogen.

British and U.S. Firms To Share Missile Data

Two leading British and American manufacturing companies recently announced that they would share technical knowledge and manufacturing techniques.

The companies are Armstrong Siddley Motors, Ltd. of London and Beaver Precision Products of Detroit. Beaver is a leading designer and manufacturer of precision actuating mechanisms used in production of missiles, aircraft, machine tools and instruments.

First Operational Firings Of *Regulus* Scheduled

First operational firings of *Regulus* II from a submarine are scheduled for some time in September off the Navy's Point Arguello facilities. Impact area will be in Utah.

The missile will be fired from the Grayback, which was re-designed during construction to accommodate *Regulus* II.

Demonstration firings already have been carried out, and test shots utilizing a weight load equal to the missile and employing solid propellant boosters have been conducted in San Francisco Bay. The firing next month will be the first shot with the missile approaching its full 1,000 mile range.

Pershing Subcontracts Show Program on Time

The naming of four major subcontractors for the solid propellant *Pershing* missile system by the prime contractor, Martin Company of Orlando, points up the varied and numerous companies engaged in the missile industry.

Bendix Eclipse-Pioneer Division, Teterboro, N.J., will build the inertial guidance system, stable platform and associated equipment. Bulova Watch Company, Long Island, N.Y. received the subcontract for the complete nuclear warhead field adaptation kit, including fuzing, safety and arming, checkout equipment, field handling and shipping containers, and power supply system, independent of the missile's auxiliary power.

Thiokol Chemical Corp., Huntsville, Ala. will design, develop and produce the *Pershing* propulsion system, using facilities at Redstone Arsenal in early stages. Thompson Products Accessories Division, Cleveland, Ohio, will make the transporter-erector-launcher.

The sub-contracts were awarded on a cost-plus fixed fee and will eventually cover four years. Best estimates for first production prototypes for tactical use is late 1962. First test firings probably will be scheduled in late 1960.

Missile Contracts Awarded Totaling $18 Million

Three contracts totaling $18 million have been awarded recently by the Army and Navy for missiles and missiles systems.

The Army awarded two contracts totaling $5.6 million to Hayes Aircraft Corp., Birmingham, Ala., for the *Jupiter* program. For production of ground service equipment, $2.3 million; for design and engineering services, $3.2 million.

Western Electric of New York City has received two contracts totaling $6.9 million from the Army for *Nike-Ajax* and *Nike-Hercules*. This work will be done in Winston Salem, N.C.; Whippany, N.J.; and Santa Monica, Calif.

The Navy has awarded a $5.5 million contract to Chance Vought for radar matching systems.

EIA Announces Increase Of Transistor Sales

Factory sales of transistors increased in June over the May level, the Electronic Industries Association has announced. Cumulative sales of these semiconductor devices increased substantially during the first half of this year over the high level recorded by EIA during the 1957 period.

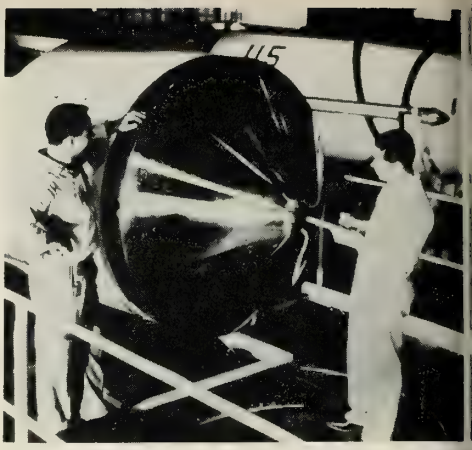
Factory sales of transistors in June totaled 3,558,094, with a dollar value of $8,232,343, compared with 2,999,198 valued at $7,250,824 sold in May, and 2,245,000 units valued at $6,121,000 sold in June a year ago.

Cumulative sales of transistors during the first six months of this year totaled 18,452,324, valued at $42,845,056, compared with 11,199,300 units valued at $31,249,000 sold during the first half of last year.

The following EIA chart shows factory sales of transistors in June and the first half of 1958:

	1958 Sales (units)	1957 Sales (units)
January	2,955,247	1,436,000
February	3,106,708	1,785,300
March	2,976,843	1,904,000
April	2,856,234	1,774,000
May	2,999,198	2,055,000
June	3,558,094	2,245,000
TOTAL	***18,452,324***	***11,199,300***





ENGINEERS MATE the nose cone to the missile at the Douglas hangar of the flight test center.

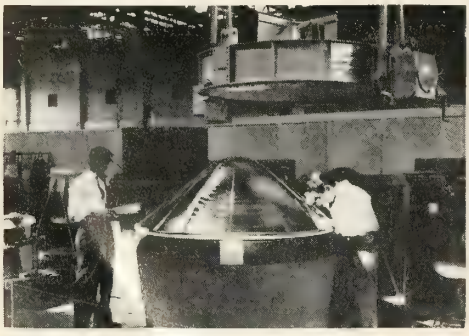
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FLIGHT TEST PERSONNEL maintain a constant watch while readying a *Thor* nose cone for a test.

Nose Cones: The Blunt Approach

Within the last few days, the Air Force has made public revealing photos of the nose cones developed and fabricated by the General Electric Co. An outstanding disclosure made simultaneously was the announcement that the entire *Thor* program was developed around a nose cone which could be used not only for the *Thor* IRBM, but also for the *Atlas* ICBM.

Utilizing the heat sink principle, final designs show a broad, blunt shield that is designed to provide the high drag needed to combat the high temperatures of re-entry velocities.



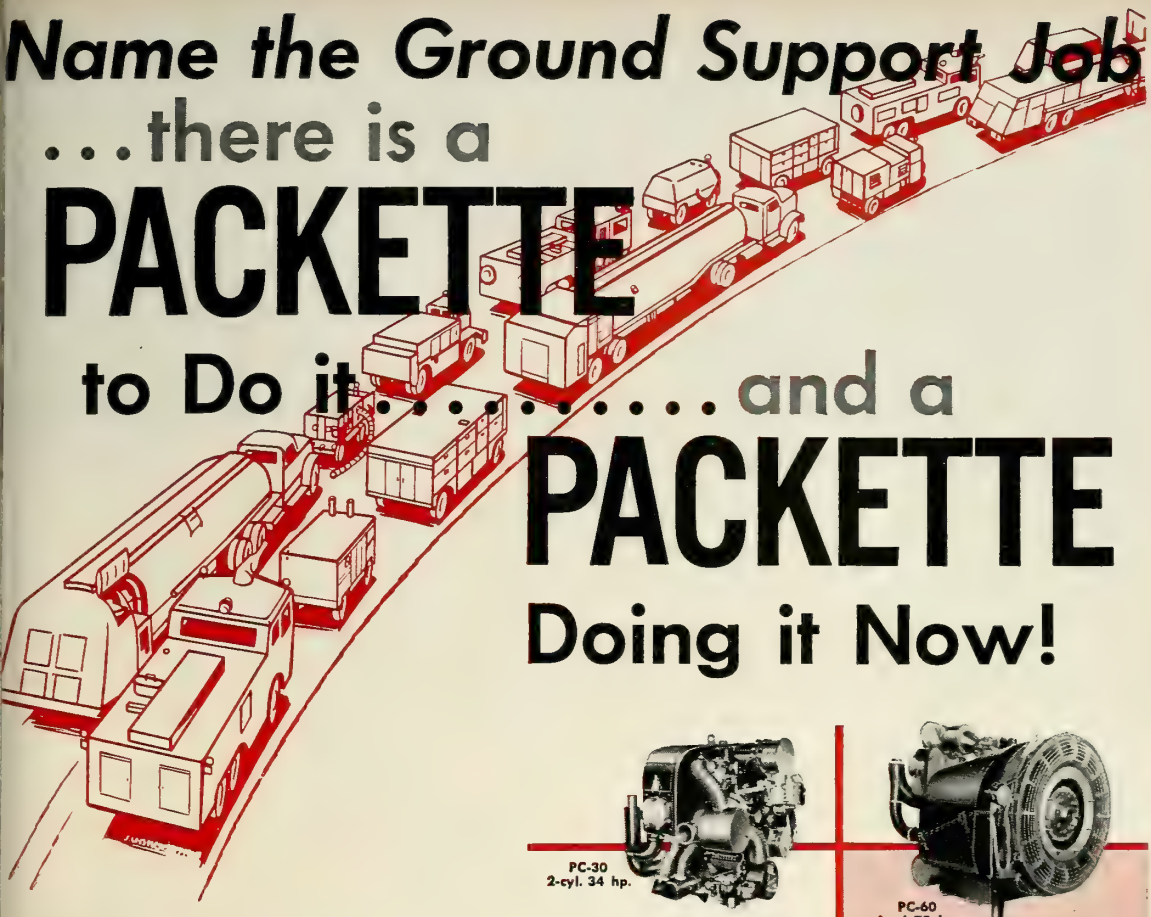
EVERY CONE arriving at the Cape receives a "pit-plotting" inspection for possible shipping damage.

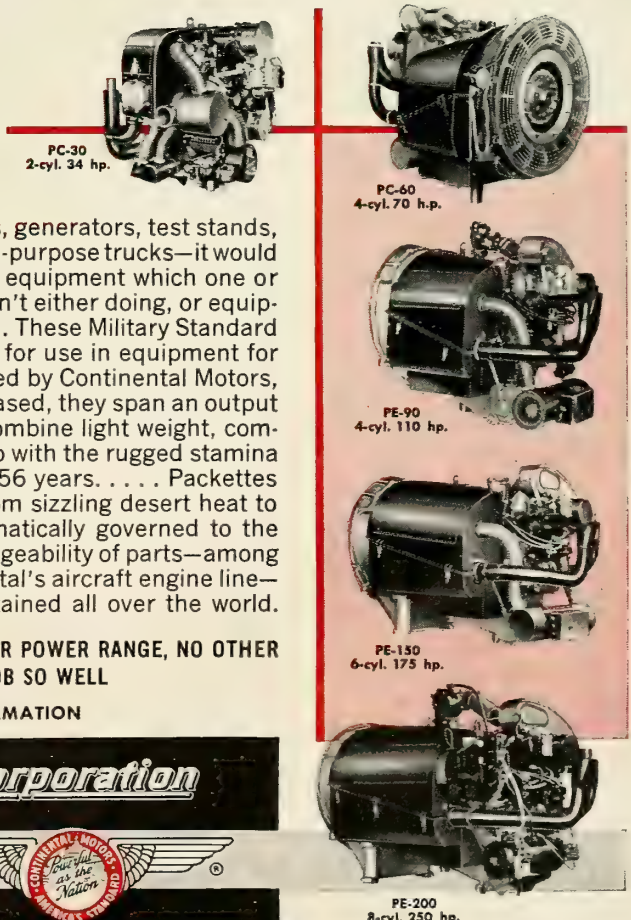


AIR FORCE CREWMEN match a missile nose cone to a simulated *Thor* instrument section at General Electric's Ordnance Systems.

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...there is a PACKETTE to Do it.....and a PACKETTE Doing it Now!





Air conditioners, crash trucks, compressors, generators, test stands, refuelers, heaters, blowers, Rollagons, multi-purpose trucks—it would be hard to name a type of ground support equipment which one or another of the five Continental Packettes isn't either doing, or equipped to do, better than any other engine. . . . . These Military Standard power plants (Mil. E-6449-A) are approved for use in equipment for all branches of the Armed Forces. Developed by Continental Motors, on whose aircraft engine models they are based, they span an output range from 30 to 250 horsepower. They combine light weight, compactness, and ease of servicing and upkeep with the rugged stamina for which Continental has been known for 56 years. . . . . Packettes are built to operate in any temperature from sizzling desert heat to 65 below zero, power output being automatically governed to the load. They feature unusually wide interchangeability of parts—among themselves and among models in Continental's aircraft engine line—and complete supplies of parts are maintained all over the world.

In short, IF THE APPLICATION FALLS WITHIN THEIR POWER RANGE, NO OTHER POWER PLANT WILL DO THE JOB SO WELL

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AIRCRAFT ENGINE DIVISION

MUSKEGON, MICHIGAN

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It takes brains . . .

to guide a missile . . . mechanical brains, that is, like this tough but tiny ***ARMA*** digital computer module. ***ARMA*** has put a great many brains to work designing a fully transistorized and miniaturized digital computer, a critical part of ***ARMA***'s all-inertial guidance system for the Air Force ICBM Program.

More brains, the human kind, are now needed for ***ARMA***'s inertial role in the Air Force ICBM Program. Specialized senior engineering and technical management positions with excellent growth potential are now available. Write to ***ARMA*** . . . Professional Personnel, Garden City, N. Y. Prompt, convenient, confidential interviews.

5836-A

AMERICAN BOSCH ARMA CORPORATION



propulsion engineering

by Alfred J. Zaehringer

Tank car shipment of LOX and other liquefied gases may be near. Linde Co. is to make available new insulation techniques, cryogenic pumps, and know-how to build railway tank cars. Could mean more and cheaper LOX for blossoming rocket test work.

Pre-mixed bipropellants? Ohio State University has successfully fired pre-mixed gaseous hydrogen and oxygen in a test rocket engine at pressures of 200-300 psi. Mixtures ranged from fuel rich to stoichiometric. Small amount of oxygen, however, is needed to keep flame from propagating back to storage tank. Such techniques may eventually make possible a practical monopropellant liquid rocket. Ohio State is also believed to have conducted tests of fuels in liquid oxygen and non-hypergolics in nitric acid.

Look to Phillips Petroleum to enter the liquid monopropellant picture. Phillips is already working on an Air Force research contract and sees single and two component possibilities. The single component approach may be a pure liquid such as a nitrated or halogenated organic. The two component system dissolves a solid in a liquid (viz., ammonium nitrate in ammonia) or a liquid in a liquid (viz., nitropropane in nitric acid). Others working on liquid monopropellants: Aerojet; American Rocket; Experiment, Inc.; Food Machinery; Hughes Aircraft; JPL; NARTS; Reaction Motors; Stauffer; Sundstrand; and Wyandotte Chemicals.

Aluminum alkyls are currently under test at Rocketdyne's Santa Susana rocket complex. Great concern, however, is over toxicity in large concentrations for prolonged periods. Possible use: ignition aid additive for hydrocarbon, alcohol, and amine fuels with LOX. Big problem is still auto-ignition in air.

Radiation effects on combustion at high altitudes could lead to problems. Two high energy radiation belts have been discovered by rocket soundings at about 12 and 26 miles. Batelle has found that radiation can break down boundary films in combustion gases and could cause combustion instability in turbojets, ramjets, and rockets. Air Force is quite concerned.

Free radicals are still too free. A recent AFOSR-Aerojet meeting in Los Angeles revealed more complications in understanding the instability of free radicals. In NBS work with free nitrogen at solid nitrogen temperatures, three basic reactions were found: transitions between metastable states, interaction between free atom and nearby molecule, and coupling beween free atom impurities and nitrogen molecules. Result: nobody has yet come near a laboratory stabilization method.

More ammonium perchlorate for solids is shaping up. HEF, Inc. is starting construction on its multi-million pound-per-year AP plant at Columbus, Miss. Lithium perchlorate will also be made, though on a small scale. HEF is a joint venture of Hooker Electrochemical and Foote Mineral.

Air-quenchable tool steels with ultimate tensiles of near 300,000 psi for high-strength, thin-walled solid motors are near, say Solar Aircraft engineers. Coatings on cheaper steels may also be important.

Nozzles for solid rockets are the critical factor, also. A big breakthrough is needed to drastically reduce weights on present heavy nozzles, particularly on high-thrust, long burning time units. Cooling is rough when burning time gets over 30 seconds. Nozzles, already critical on *Polaris*, will need new approach on *Minuteman*.

Cavitation detector for liquid propellants has been developed by AiResearch. For use in missile ground test systems or flight test vehicles, the detector can sense bubbles 50 mils in diameter in a 6 inch diameter line. It can also detect foreign particles such as sand.

National Guard Units To Take Over *Nike* Sites

National Guard Units will take over operation of *Nike* guided missile sites around Los Angeles in September, the Army has announced. This will inaugurate a program for operation of air defense missiles by Guardsmen.

For the first time, the Army identified states other than California where National Guardsmen will take over operation of some anti-aircraft guided missile installations. They are:

Connecticut, Illinois, Maryland, Massachusetts, Michigan, New Jersey, New York, Ohio, Pennsylvania, Rhode Island, Virginia, Washington, Wisconsin, and Washington, D.C.

The California Guards's 720th anti-aircraft missile battalion will take over four *Nike* sites in the Los Angeles area.

Redstone Probably Used In Nuclear Test Blast

A *Redstone* probably was used in the recent Johnson Island test of the explosion of a nuclear warhead in space.

Part of the Atomic Energy Commission's Hardtack series of nuclear tests in the Pacific, the blast was the first exploratory effort to determine how a nuclear explosion works at high altitude. The warhead reportedly exploded at an altitude of about 100 miles.

Nuclear explosions in space are being researched for their applicability in the nation's anti-ballistic missile defense system. It is believed, by some scientists, that high-energy neutrons generated by an atomic blast could travel great distances in space and could trigger an incoming ICBM while it is on its ballistic flight path.

Reduced Costs Seen For Satellites In Space

The costs of putting satellites into space may be reduced soon, according to Dr. H. J. Stewart, division chief, design and power plants department, Jet Propulsion Laboratories. Speaking at the recent Third Annual National Photo Instrumentation Symposium, Society of Photographic Instrumentation Engineers, Dr. Stewart pointed out that it now takes 3,000 lbs. of starting equipment to put one pound of satellite aloft.

"With even low level technology, we shall soon be able to bring the ratio down to 100 to 1 and perhaps as low as 25 to 1," he predicted. Much of the data necessary for solving space age problems will be furnished by photographic instrumentation systems, Dr. Stewart declared.

Navaho System Guides *Nautilus* Exploit

The recent trip of the atomic submarine *Nautilus* under the polar ice cap pointed up a fact of major importance: the ship was guided by a system developed for a defunct missile—the Air Force *Navaho*. Thus, despite cancellation of the weapon, its guidance system has been converted to other defense uses.

The system that guided the *Nautilus* was the pure inertial guidance system originally developed for *Navaho* by the Autonetics division of North American Aircraft.

It contsists of a platform stabilized by three liquid-floated gyros and mounting three pendulous integrating accelerometers. The accelerometers sense deviations from a predetermined course, in three dimensions, and their signals are fed into computers which determine the corrections to be applied to the submarine. When the submarine is again on course, a null results in the accelerometer error signal output and no corrective signals issue from the computers.

• **Four days**—The outstanding fact of this announcement is that the inertial system operated for four days, although most inertial systems for ballistic missiles are required to work for not much more than 30 minutes.

This means that a system such as the *Navaho* could be used for moon flights without the addition of stellar correction, as is needed in the *Snark*. Designers will be able to insert the flight program into the guidance system on the ground, confident that the moon vehicle will correct itself for gyro.

Officials at North American have confirmed that the company is also manufacturing similar systems for nuclear submarines now under construction in the *Polaris* program. How this will fit in with the Sperry SINS (Shipboard Inertial Navigation System) was not announced, but it is known that the SINS depends on occasional stellar correction for pinpoint position.

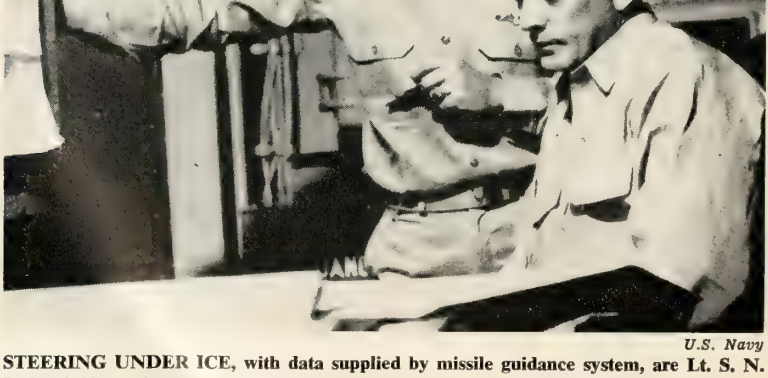
It might be that the North American system will be used for general navigation and the Sperry system for actual missile firing. This is borne out by the fact that the SINS actually sets the azimuth of the *Polaris*.

The guidance system is not the only element of the *Navaho* that is contributing to the defense effort. North American is the engine partner on the Boeing Dyna-soar team, and it is reported that the 400,000 lb. booster used on the *Navaho* might be the main propulsive force used to get the Dyna-soar off the ground.

Project Manager For *Minuteman* Announced

Appointment of Jesse Y. Bowman as Autonetics Project Manager for the USAF *Minuteman* missile's guidance and control system has been announced.

Selection of Autonetics, a division of North American Aviation, Inc., to develop the *Minuteman* missile's guidance and control system was announced recently by the Air Force.



U.S. Navy

STEERING UNDER ICE, with data supplied by missile guidance system, are Lt. S. N. Jenks (left), navigator, and Cmdr. W. R. Anderson.



LONG distance firing controls, as . .

SAGE Guidance Is Teamed With *Bomarc*

The first computer for SAGE (Semi-Automatic Ground Environment), an Air Force detection and communication system designed for coordinated defense against air attack, has been teamed with the *Bomarc* surface-to-air missile in a successful long distance test.

The SAGE computer, located in Kingston, N.Y., was used to fire and guide the interception of *Bomarc* from the long-range test site at Cape Canaveral, Fla. The Kingston-controlled test was set up to determine the compatibility of the *Bomarc* control and guidance and the SAGE computing system. The Air Force reported the successful completion of a planned near-miss interception by the missile with an airplane target drone over the Atlantic.

The earlier *Bomarc* test missions were controlled from a Boeing-designed ground guidance center at Patrick AFB. Last month the Kingston SAGE center began monitoring the Florida controlled launchings.

The distance between the *Bomarc* launching site and the SAGE system is of little importance. A telephone communications system connects the computer with the radar which searches for the missile's target, and the surface-to-air transmitting station at the missile site. "Instructions" are transmitted through an IBM card system between radar, computer and missile without human intervention.

The SAGE system of ground control will make it unnecessary for each missile base to have its own control center. When fully operational, there will be about 30 SAGE direction centers.

SPECIFICATION: Stainless Steel Honeycomb "Sandwich"

FIRST SOURCE: AERONCA



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Large capacity precision brazing furnaces.

Superior honeycomb structures in production quantities.

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Stainless steel brazed honeycomb "sandwich" structures are solving critical thermal, dimensional and strength-weight ratio problems in the latest air weapons systems.

Aeronca . . . a pioneer in stainless steel honeycomb development . . . *is one of the few companies actually producing these high-temperature structures in quantity.* Flat, wedged, conic, contoured and compound curved sandwich panels are being delivered by Aeronca for application in missiles and supersonic aircraft.

Let Aeronca's *practical experience* and fully integrated facilities help you solve airborne structure or component problems.

Write today for details. Formal letterhead inquiries will receive immediate attention.

BASIC ADVANTAGES OF HONEYCOMB FABRICATIONS

1. Superior strength-weight ratios.
2. Outstanding thermal stability.
3. Excellent resistance to acoustic shock and fatigue.
4. Greater aerodynamic smoothness.
5. Simpler sealing techniques in pressurized areas.
6. Increased usable volume.
7. Fewer detail parts or components.

Expansion of our operations has created openings for additional qualified senior engineers. For information, write to Mr. L. C. Wolfe, Chief Engineer.

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WESCON to Highlight Three Special Sessions

With more than 900 exhibit booths and 42 technical sessions scheduled, the 1958 Western Electronic Show and Convention (WESCON) will open August 19, in Los Angeles, Calif., sponsored by the 7th Region, IRE, and the West Coast Electronic Manufacturing Association.

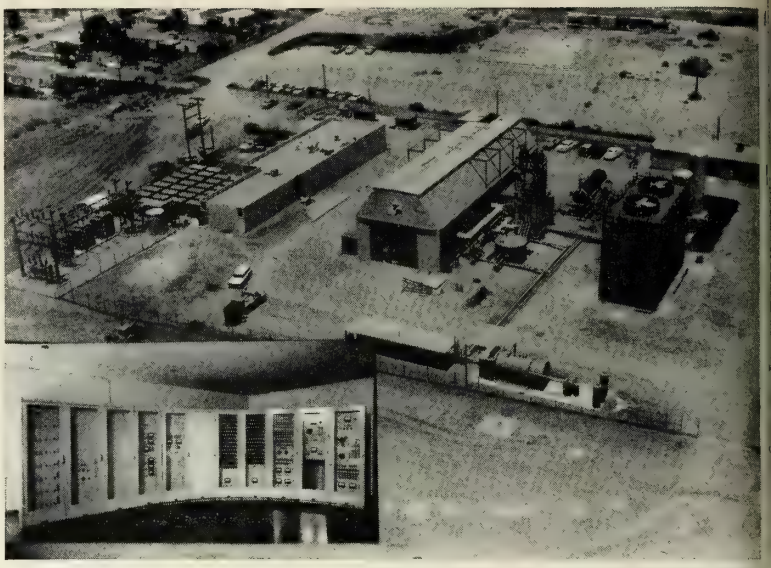
In addition to the standard presentations, three special sessions are scheduled. One, "Industry Looks at Fusion Power," will consist of a panel discussion with Robert Hughey, AEC, as moderator. Speakers will be Henry Hurwitz, General Electric Co.; Samuel Cunningham, General Atomics Corp.; and William J. Lange, Westinghouse Electric Corp.

The second special session, "Biological Measurement in Space Travel," will be moderated by Dr. Robert Tschirigi, UCLA. Panel members will be Brig. Gen. Don Flickinger, special assistant for bio-astronautics, ARDC, Washington, D.C.; Dr. Blaine H. Levedahl, assistant professor of zoology, UCLA; Dr. Albert Walter Heatherington, technical advisor, Human Factors Div., ARDC, Baltimore; Miss F. Van Der Wal, technical staff, Ramo-Wooldridge; and Frank W. Lehan, consultant to Space Technology Laboratory, Ramo-Wooldridge.

Arrangements are made for still another special session, "Project Management—Airframe or Electronics." This timely and controversial subject will be presented in panel form, moderated by Col. Edward N. Hall, USAF Ballistic Missile Division, Inglewood, Calif. Speakers will include George Stoner, weapons system project manager, Boeing Airplane Co.; Oscar Simpson, manager, Western Development Laboratory, Philco Corp.; and Richard L. Shetler, manager, Missile Guidance, Defense Electronics Div., General Electric, Syracuse. Sponsored by the IRE professional group on engineering management, the panel is "charged" with clarifying the positions of the airframe and electronics industries.

Eight field trips are being offered to delegates. These include a visit to Litton Industries; Thompson Products in Inglewood; Helipot Corp. and Altec-Lansing; March AFB; Beckman Systems Div. and Hallamore Electronics; Hughes Standards Laboratory; and a tour through an Air Force RC-121D Lockheed Super Constellation AEW aircraft at Burbank.

• **Technical sessions**—In the technical sessions, heavy accent will be placed on reliability, microwave theory and techniques, and solid-state electronic components.



ENGINEERS ATTENDING Western Electronic Show and Convention at Los Angeles, Aug. 19-22, will make a field trip to the Thompson Products missile systems ground test facility in Inglewood. Inset shows a laboratory section capable of handling 800 channels of information on electronic data processing and acqusition systems.

The reliability sessions include a panel discussion, "Contract Implications of Military Electronics Reliability Requirements," moderated by E. J. Nucci, Office of Assistant Secretary of Defense.

In a paper, "Design Techniques for Upgrading the Reliability of Weapon Systems During Flight-Readiness Checkout," Melvin Patterson, Radioplane, will point out that system contractors have been slow to recognize the importance of design refinement in electronic support equipment. Powell will also emphasize the need for checkouts that project future performance, rather than present.

Reliability specifications and related acceptance tests must be better understood by those who use the test results, says Cliff Ryerson, RCA, Camden, who will speak on "The Confidence That Can Be Placed on Various Reliability Tests." Ryerson will explain such specs as Mil Standard 105 tables, and sequential sampling techniques.

Some conventional methods for determining reliability are inadequate in terms of improvement vs. the engineering effort expanded, declares James H. S. Chin, Sperry Gyroscope Co. Chin will describe the new technique of group redundancy and its relation to product improvement, in terms of engineering effort.

• **Microwave theory**—The 10 papers on microwave theory and techniques will include "Mode Conversion Filters," by E. A. Marcatili, Bell Telephone Labs; "Properties of the H-Guide for Microwave and Millimeter Waves," by F. J. Tischer, Ohio State University; "Power Handling Capacity of Slab Lines," by G. Badoyannis, Sperry Gyroscope Co.; "RF Circuits for a Voltabe-Turnable Magnetron," by W. J. Gemulla, Electronic Defense Laboratory; "An S-Band Two-Phase Demodulator," by Robert B. Wilds, Sylvania Electric Products, Inc.; "Solution of Some Microwave Problems By an Analog Computer," by Donald M. Byck, EAI Computation Center, and Allen Norris, Varian Associates.

New artificial dielectrics are needed for construction of large-scale microwave lenses such as a Luneberg lens, according to Ming-Kuei Hu and David K. Cheng, Syracuse University. The units should be lightweight, isotropic artificial dielectrics with a controllable refractive index.

The speakers will suggest such a device, which is a random arrangement of a large number of artificially made lightweight elements in the form of two concentric spherical shells. The outer shell is a dielectric material, and the inner shell is made essentially of conducting material. The proposed dielectrics are believed to be favorable with other known types in homogenity, bandwidth, loss and cost.

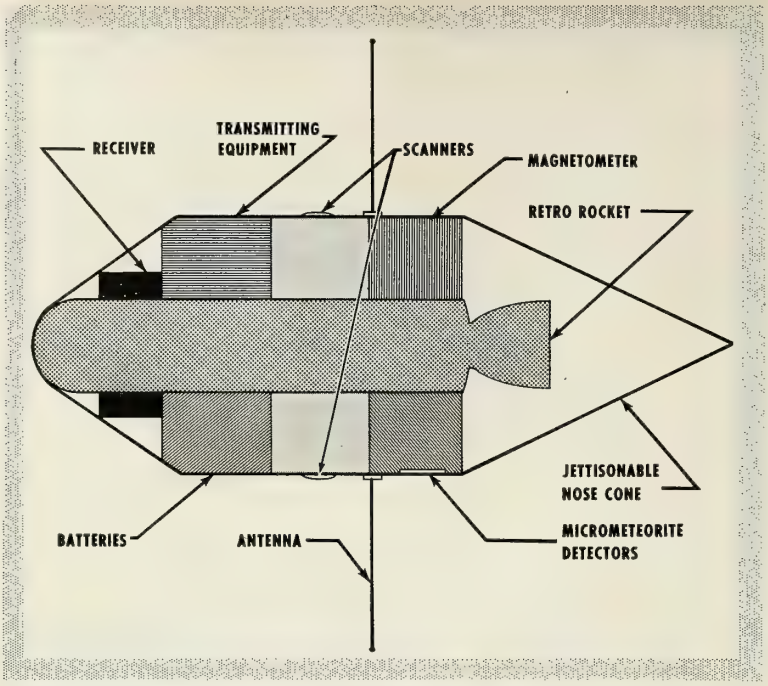


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PROBE COMPONENT of Air Force's Lunar shot might look like this sketch, drawn by m/r's staff artist. Cross section indicates "doughnut" shape of probe.

Moon Probe Readied For Launch

by Raymond M. Nolan

Despite the fact that the Lunar Probe attempt (in countdown as m/r went to press) is labeled a "scientific experiment" with no military significance, the Advanced Research Projects Agency and the Department of Defense have been extremely chary of releasing any details.

This much is known:

The first Lunar Probe vehicle is a *Thor-Able* combination with a *Thor* IRBM as the first stage, a radically modified *Vanguard* second stage, and a high-energy solid propellant third stage.

On top of this is the probe, described by ARPA's chief, Roy Johnson, as "doughnut-shaped," but more probably resembling the cross-section sketch shown here. The probe will contain a retro rocket (forward firing) to slow it down when it is in proximity to the moon. It will also attempt to place it in orbit on the moon.

Instrumentation for the photography the Air Force hopes to accomplish includes:

- one or more photo-electric scanners,
- a vidicon tube to record the scan,
- radio equipment and batteries to beam the information back to earth,
- a magnetometer to check the magnetic field of the moon (if any)
- a micrometeorite detector.

Transmission will probably be accomplished by four whip antennas working on a frequency around 2250 Mc/s.

• **Transmission**—Several approaches could be used for scanning, if the shot is successful. One picture could be taken as the probe made its first, and possibly its only orbit, and then play back to earth slowly over a period of two hours. Or a number of pictures could be taken, with playback occurring between pictures.

The probable size and weight of the probe indicate that transmitting equipment will have a power level of 3 to 10 watts in the power stage of the transmitter, with about 30 to 40% effective radiation off the antenna. Tracking stations will include the radio telescope in Manchester, England, and stations in San Diego, Hawaii, Singapore, and Cape Canaveral.

• **Firing sequence**—If things proceed according to schedule, the sequence will go something like this:

As the countdown ends, the *Thor-Able* will be fired on a vertical trajectory and tilt to its proper pitch angle during the powered phase of its first stage.

When the first stage burns out and separates, the remaining stages will coast for a short time, and then the second stage will ignite (presumably any deviations from a proper course will be corrected by equipment in the second stage.)

The second stage will burn out and separate, leaving the third stage and probe traveling at 18,000 mph.

Another coasting period will ensue, and then the third stage will ignite, providing the additional boost needed to achieve 25,000 mph.

Finally, the long, unpowered, unguided flight of a little more than two and one-half days.

As the probe nears the moon, a scientist at a post in Hawaii will touch a button to ignite the retro rocket, slowing the probe down to a velocity which will allow it to be captured by the moon's gravitational field. If this is successful, the probe will go into orbit. How long it remains, or where it goes after orbiting one or more times, is anybody's guess.

• **Fifty-fifty**—ARPA Chief Scientist Herbert York estimates the chances of the Lunar Probe going into orbit at something around 50%; of missing the moon entirely and continuing on into space, about 25%. ARPA Chief Roy Johnson uses a little different figure and guesses success to have a "1 in 10" chance.

This probe will be the first of three attempts by the Air Force and will precede the Army's projected two attempts by a couple of months. Reports are that the Army is presently by-passing its lunar probe program in favor of more *Explorers* to investigate the band of intense radiation uncovered by the first earth satellites.

When the Army does fire its probe, the first stage of the *Juno* II vehicle will be the *Jupiter* IRBM, with upper stages identical to the *Explorer Jupiter-C* (or *Juno* I) vehicles.

These consist of a circle of 12 scaled-down *Sergeant* missiles as a second stage, surrounding a cluster of three scaled-down *Sergeants* as a third stage, and supporting a single scaled-down *Sergeant* as the fourth stage.

Unlike the *Thor-Able* which will assume its attitude in the air, *Juno* II will be trained in azimuth on the ground and fired in the optimum direction. Its probe will be a single-pass affair, designed to take one picture and transmit it back to earth. No additional instrumentation will be carried.

After the picture is taken and sent back, the probe, its batteries dead, will take an unknown course.

Britain, Red China Enter Satellite Race

by Frank G. McGuire

Increasing reports are circulating in Western countries concerning the possibility of the Red Chinese launching artificial earth satellites.

The president of the Chinese Academy of Sciences, Mr. Kuo Mo-Jo, has stated that "China's scientists are determined to get China's artificial earth satellite into the sky at an early date."

Observers here and in Great Britain are inclined to regard the statement with some respect, noting that the political advantages of such a launching would be tremendous. Scientists in Great Britain are advocating the launching of a British satellite, to offset the propaganda onslaught which would result.

Soviet technicians and launching vehicles would likely be used in the operations, and perhaps the only part of the feat which would really come from the Soviet-bloc countries would be the instrumentation of the satellite itself.

For this reason, The British Interplanetary Society is strongly pressing for establishment of a British space flight program. Government sources in London have confirmed that there are hopes of using some of Great Britain's larger powerplants as satellite-launching vehicles. Those under consideration include the *Black Knight* and *Blue Streak* rocket engines.

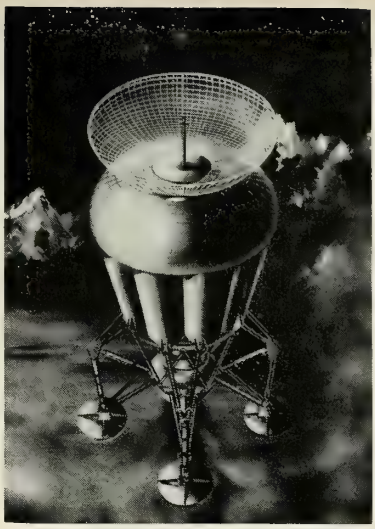
The B.I.S. has pointed out that despite the fact that minimum orbital satellites were proposed by its members as early as 1951, there still is no real program in existence to launch a satellite as soon as possible.

Prof. A. C. B. Lovell, director of the radio-astronomy station at Jodrell Bank, said the United States has plans to "sell space" in its satellites to underdeveloped countries.

Although admitting that it would be "ludicrous" for Great Britain to attempt a space flight program of the magnitude of either the U.S. or the Soviet Union, the British Interplanetary Society proposes that work be carried on beyond the present *Skylark* upper-atmosphere research program and current missile projects.

The B.I.S. maintains that the question that remains unanswered is—"How long can we afford to ignore space research without seriously harming our scientific stature and without seriously impeding new avenues of research which will become increasingly vital to us in the future?"

At a recent youth conference, the Duke of Edinburgh said: "I personally



cannot believe that the British people or the people of the Commonwealth will be content to sit by and watch others explore the universe around us."

Titan Guidance System Contract for *Atlas* OK'd

The Air Force is expected to use all-inertial guidance for the *Atlas* intercontinental ballistic missile. This will mean a substantial contract increase for the Arma Division of American Bosch Arma Corp., Garden City, New York, Charles W. Perelle, president, recently announced.

According to Maj. Gen. Bernard A. Schriever, commander of the Ballistic Missile Division, progress made in the development of an all-inertial guidance system for the ICBM by Arma, will result in its earlier introduction into the *Atlas* program than was originally planned.

Opposition Voiced to Missile Planning Reports

The aircraft industry has expressed opposition to the Missile Manufacturers Planning Reports, under consideration by the Bureau of the Budget. (See m/r, August 4, p. 12) Industry spokesmen cited serveral major reasons for their opposition to the forms:

- There are already reports in existence which satisfy "better or equally well" the administrative needs stated by the military services.
- The detailed data required by the MMPR forms is often unavailable.
- The forms would result in duplication of information already supplied on forms AMPR, Program Progress Reporting, WDD56-1, and others.
- It is unfair to ask industry to revise its internal reporting systems merely to satisfy government requirements.
- The use of manhours as a measure of effort is not common to all industries in the missile field.
- It is impossible to develop instructions and definitions which allow for the variation between company methods of operation, and yet provide reliability.
- Considering the variations in company accounting systems throughout the industry in aircraft, electronic, automotive, machinery, and others, much of the information required by the MMPR forms could only be estimated.

Aircraft industry spokesmen also cited various "unresolved areas" left by the MMPR forms: applicability (reporting other than production-status missiles); reporting indirect manhours; reporting by segment; breakdowns into fabrication, subassembly, test, spares, etc.; weight breakdown; reporting of manhours instead of dollars; understandable definitions.



ALMOST INSTANTANEOUS ACCELERATION to 18 Gs is achieved by this Lockheed X-7 missile as it blasts two feet along the rails of this specially designed "G-Shooter" at Halloman AF base. The X-7, used to test ramjets for the Air Force, is the fastest and highest flying air-breathing missile in the free world. Performance details are still classified.

missile people in the news



Charles J. Wiley has been appointed market development manager of Callery Chemical Company. He will be responsible for market activities of chemical products under research and development at Callery, it was announced by the company recently.

William A. Cuddy will head the liquid propellant combustion section in the contract research department of Wyandotte Chemicals' Research and Engineering Division. Cuddy has been a member of Wyandotte's research staff since 1950.

Maxwell C. Scott has been named assistant manager of Buffalo operations for Sylvania Electronic Systems, a division of Sylvania Electric Products, Inc. Scott, who had been manager of the New Amherst Engineering Laboratory, will make his headquarters at the Electronic Systems Plant in Buffalo.

James L. Anast, Technical Director of the Airways Modernization Board, Washington, D.C., will join Lear, Inc. as assistant to the president for technical planning. He will advise the president on advanced engineering and product planning and will maintain liaison on advanced technical matters between the company, customers and government organizations.

Dr. W. T. von der Nuell, former director of DVL Institute for Turbomachinery in Berlin and onetime member of the German Academy of Aeronautical Sciences, has been appointed chairman of a corporate five-man research board, established by The Garrett Corp. The board will review and direct research activity and maintain long-range studies of component system requirements in space. Other board members are: **Dr. John Mason, A. P. Kelley, Hans Egli** and **J. E. Chapman.**

Robert R. Pierce will manage the Corrosion Engineering Products department of Pennsalt Chemicals Corp. He has been with the company for 17 years, working in plant, technical service and sales management.

Rear Admiral James E. Leeper, USN (Ret.) has been named vice president for the Washington area of the Philco Corp. Since his naval retirement in 1956, he has been special representative, TechRep Division of Philco.

Air Materiel Command's Directorate of Procurement and Production has announced a number of re-assignments of officers. New assignments result from retirement of **Col. H. G. Spillinger,** chief, production engineering staff division; **Col. E. H. Wilson,** chief, areonautical equipment division; **Col. John N. Dick,** chief, manufacturing methods branch; **Col. C. L. Munroe,** chief, industrial resources division; and **John W. Schwinn,** assistant to director of procurement and production.

Col. R. O. Mitterling will succeed Col. Spillinger, **Col. M. C. Smith** will succeed Col. Wilson, **Col. Preston L. Hill** will take over Col. Dick's position.

Col. J. L. Zoeckler has been assigned as deputy chief, ballistic missile office, Inglewood, Calif. He will be followed as assistant deputy director for weapons systems by **Col. L. F. Tanberg,** former chief of airlines, maintenance and service contracts division, who will be succeeded by **Col. E. N. Odell.**

Col. T. J. Kennedy takes over the newly-created post as special assistant for industrial equipment to the deputy director of production. **Col. W. R. Carter** is new assistant deputy director of production, resigning his position as chief, production management staff division.

Six Weapons Systems Procurement Offices will receive new chiefs: **Col. E. F. O'Conner,** B-52, will be succeeded by **Col. S. A. Dallas; Col. W. E. Chambers** will take over as chief F-108 from **Col. B. C. Downs; Col. H. M. Harlow** will be new chief of F-102/F-106 in place of **Lt. Col. H. G. Reed.**

Col. P. J. Guhl will succeed **Col. Pirruccello** as chief of transport WSPO and, in turn, will be replaced by **Col. C. E. Moore** as chief of facilities branch of the industrial resources division.

Col O'Conner will go to the Air War College, **Col. Downs** goes to the Directorate's electronic defense systems division at New York. Chief, resources branch will be filled by **Lt. Col. Joe McNeil. Col. R. H. Cobb** will succeed **Lt. Col. R. J. Hagreen** as chief, tactical missiles. **Lt. Col. A. D. Hoover** is succeeded by **Col. B. F. Kelly.**



Jerome E. Becker has joined Kaynar Mfg. Co. Inc. as sales engineer to represent the Kaylock line of self-locking aircraft nuts. His appointment announces the establishment of additional sales and service coverage in the Southern California area.

H. W. Bissell has been appointed to the newly-established position of personnel division manager of Lockheed Missile Systems division. He will assume his new post at the Sunnyvale plant, the company announced.

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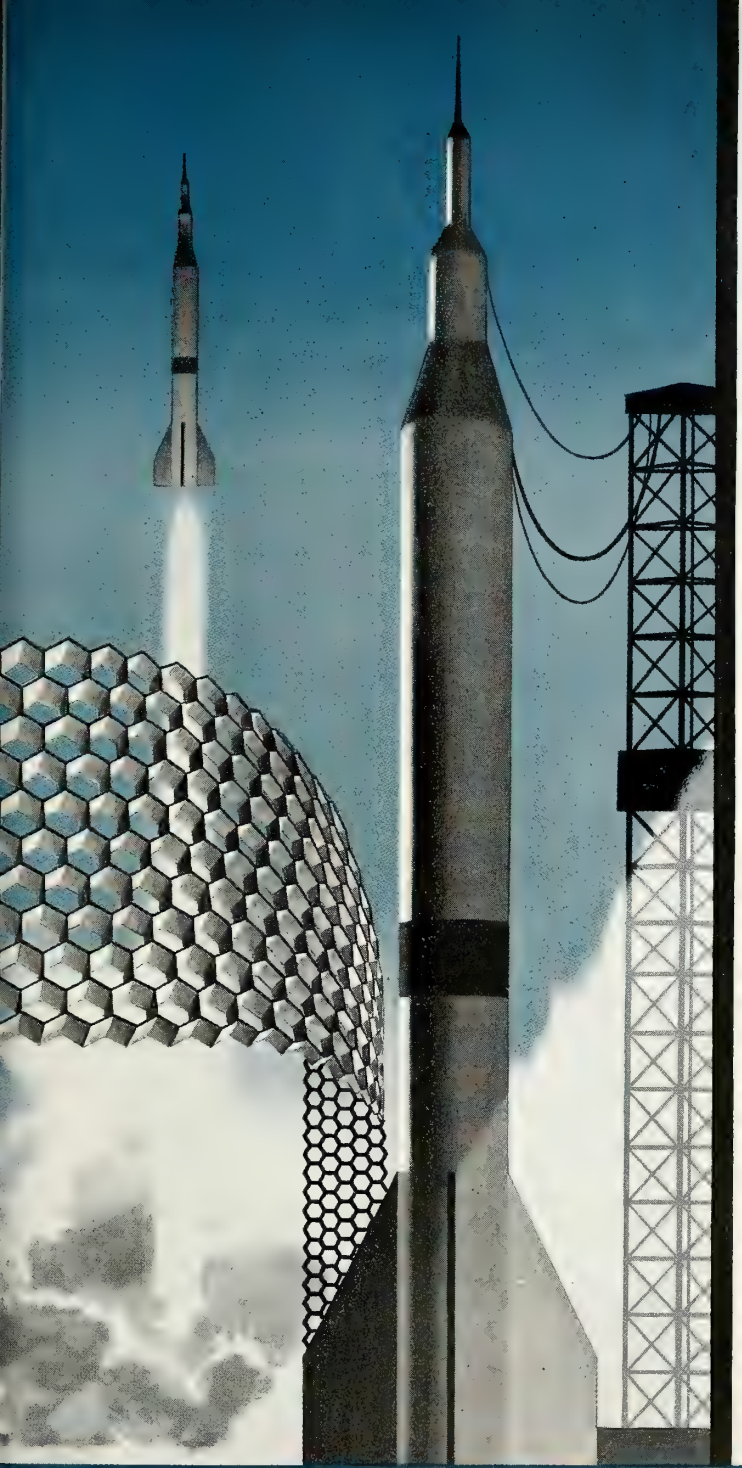
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advertiser's index

Aeronca Mfg. Corp.	29
American Airlines, Inc.	22
American Bosch Arma Corp.	26
Astrodyne, Inc.	2
Avco Mfg. Corp., Crosley Div.	35
Bulova Watch Co., Research & Development Laboratories, Inc.	15
Burroughs Corp.	20
Continental Aviation & Engineering Corp., Sub.—Continental Motors Corp.	25
Diversey Engineering Co.	4
English Electric Co., Ltd.	10
Hunter Douglas Aluminum, Div. Bridgeport Brass Co.	3
L. O. F. Glass Fibers Co.	7
North American Aviation, Inc., Autonetics Div.	31
Rheem Mfg. Co., Aircraft Div.	36
Ryan Aeronautical Co.	16
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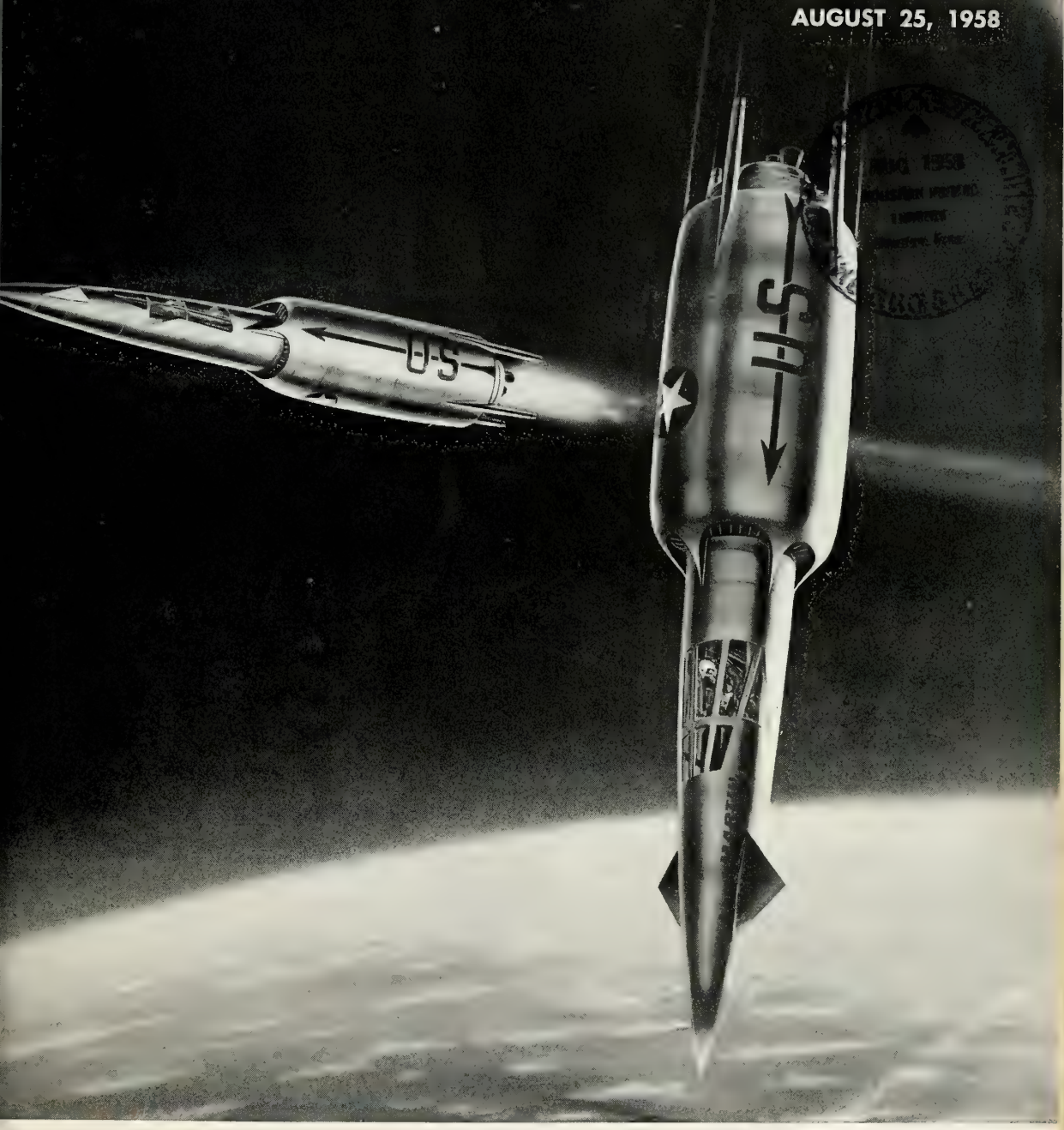
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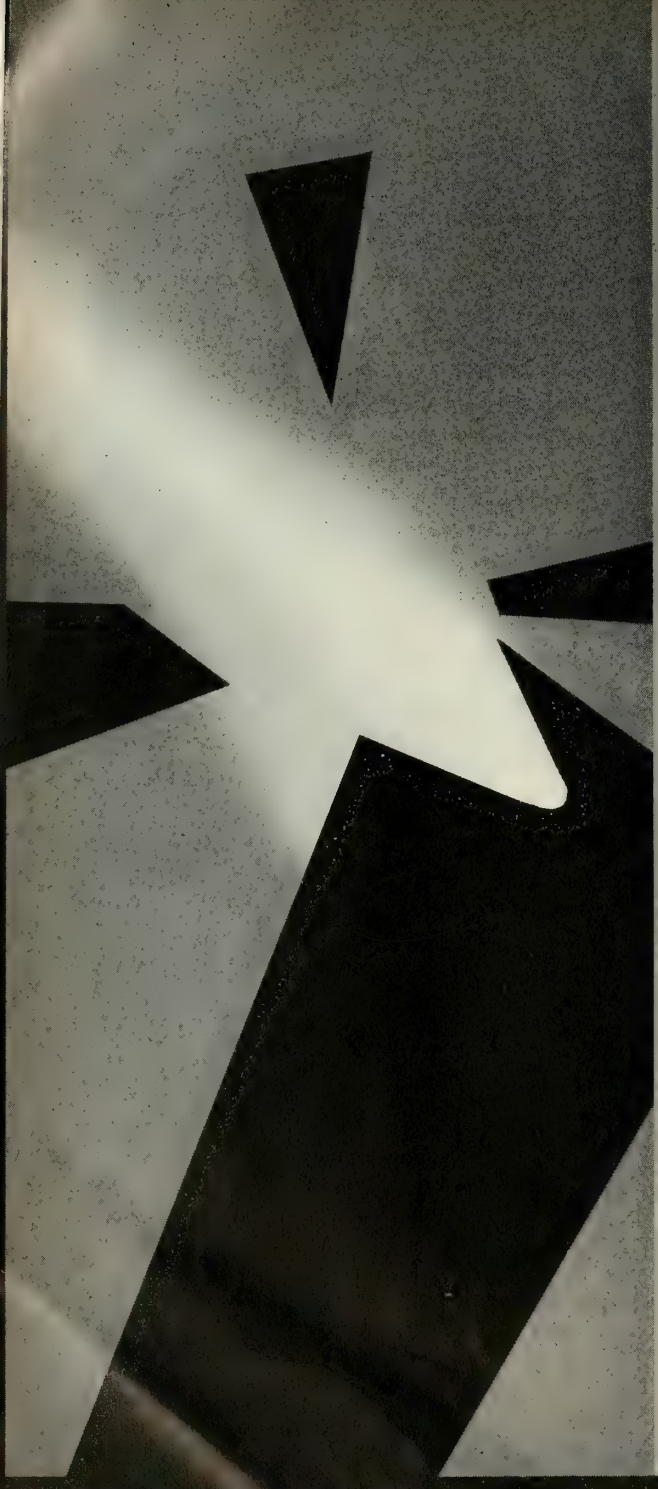
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news

Moon Shot "Major Accomplishment:" Schriever 13

Mars, Venus: Next on U.S. Schedule 15

Red Moon Stunt Seen Likely 16

features

Vandenberg . . . Space Base, U.S.A.
by Norman L. Baker 20

Missile Electronics Growth Important to Florida Economy
by Donald E. Perry 28

Space Doctor Seeks Survival Solution
by Erica Cromley 32

Packaging Missiles for Mobility 35

columns

Astrionics 37

departments

Editorial 7

Industry Countdown 9

When and Where 19

Missile Electronics News 38

New Missile Products 43

Letters 44

Contract Awards 47



cover

Re-entry vehicle envisioned by the Martin Company would provide the stepping stone between satellites and manned space vehicles. The manned re-entry craft would use liquid engines and draw on presently-existing hardware. Martin, however, has never formally proposed to develop the vehicle. Artist: N. Stanilla; Designer: Michael Stoiko.

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The Moon—Or Bust

The moon—or bust—this is a phrase with much meaning. The Air Force made a nice try on August 17. It was as much of an accomplishment and as important to space flight as the Wright brothers' first flight was to air power. Indeed, the importance of lunar vehicles, in our struggle for military supremacy in the future, is as great as the Wright brothers airplane has been to the struggle for air supremacy in past years. Many lunar rockets may "bust" and fail. More significant, however, is the fact that *the nation itself may bust* if we don't move *ahead* in the race to the moon.

The full measure of tragedy in the Air Forces' first unsuccessful lunar attempt is not to be found in the blow-up of the vehicle itself, but in the political failure to grasp what the lunar program is all about.

For some mysterious reason, Administration officials are constantly telling the public that the lunar program is an all-scientific affair—under the auspices and for the benefit of the International Geophysical Year.

This is only half true. The significance of the lunar program is to be found in its military value. Must we continue to fool the public with half-true excuses in order to permit the military to plan ahead?

There can't be many U.S. citizens who don't know that our missile and space flight programs —and indeed, our way of life—are at stake.

The freedom-loving American is prepared to *back the military*. He is prepared to pay for any form of advanced research and for any kind of exploration that may lead to a stronger America. He doesn't accept the incomplete concept of "catching up with the Russians"—he wants to move ahead of them.

He has read about Russian lunar plans—he knows it is a matter of days or weeks before the Russians may win another big space victory. With the powerful rockets they must have used to launch their *Sputniks*, the Soviets have the definite and immediate capability to fire a payload of possibly over 1,000 pounds on a one-way trip to the moon. He knows the Russians plan to build bases on the moon. So why not tell the truth about our own lunar program?

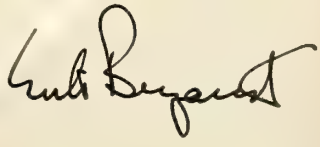
The simple truth is that our military are beginning to understand the strategic value of the moon. To say that the moon will not be of military importance in the future of mankind is to ignore the facts. Military experts say that if we consider the immense power and growth potential of these new weapons—guided missiles and space vehicles—it is clear beyond any question that the next few years can put humans in control of the moon. Considering the many factors that favor moon-launched versus earth-launched operations, it is also obvious that the question of dominance on the moon adds up—in a very positive fashion—to dominance on earth.

The most critical goal toward which Air Force major research and development efforts now are pointed is that of putting man into space: only through success in this endeavor can we command the high ground of space operations—the moon.

Very few Air Force officials and very few—if any—of our political leaders have shared this view until recently. If men like Air Force General Boushey and our rocket scientists could have joined forces and pushed their cases five or ten years ago—as Admiral Rickover's team did—the first manned moon trip might have been almost as far advanced today as is the atom-powered submarine.

Nevertheless, the Air Force and the Army are beginning to push ahead in their current lunar attempts. And they have our full support, because we believe the immediate psychological and the future strategic importance of the moon calls for an intensive, penetrating program. We also believe that the military aspects must be brought to the attention of the public as well. Certainly, Administration officials must begin to understand them.

If it is the destiny of mankind to live in a world dominated by cold-war co-existence, then we must remain the strongest. In addition to having the best Army, the best Navy and the best Air Force—we must be best in space. One way of advancing ahead toward this goal is to authorize, right now, a permanent *military* lunar program. It should be done by the military under ARPA and *not* under the camouflage of NASA.



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Volts: 56 volts DC

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INDUSTRY COUNTDOWN

HOW'S BUSINESS?

Net income of **Food Machinery and Chemical** for the quarter ended June 30th dropped to $5,002,807 from $5,181,169 in last year's quarter. Per share earnings were $1.45 vs. $1.51 for 1957's quarter . . . **Grumman Aircraft Engineering** published earnings of $1,030,804 for the six months ended June 30th, compared to $2,123,469 for same period in 1957. Earnings per share declined to 47 cents from 97 cents. The decline was accompanied by an increase in sales from $90,603,052 to $107,523,602; but Grumman blamed the drop on R&D costs on its new Gulfstream prop-jet transport . . . **Texas Instruments** has second-quarter sales of $21,710,250 and net earnings of $1,035,117 or 32 cents per share, to bring totals for six months to $42,189,584, $2,142,861 (66 cents per share). Figures were the best for any six month period in the company's history. Predicted earnings for 1958 are $1.40-$1.45, compared to $1.11 for 1957 . . . **Northrop Aircraft** declared a quarterly dividend of 40 cents a share . . . Net income for **Bendix Corp.** fell to $4,670,740, or 92 cents per share from $7,099,215 or $1.40 for the quarter ended June 30th. Sales were $155,278,951 compared with $194,706,859 for 1957, second quarter . . . **Ampex Corp.** jumped sales to $30,115,000, net income to $1,540,000; but dropped per share earnings to 90 cents for the 1958 period ending on April 30th. Comparable figures for same period in 1957 were sales, $18,737,000, net income, $1,087,000, and per share, $1.51 . . . Earnings of **Sperry Rand** for the quarter ended June 30th were $3,920,271 (13 cents a share), off 60.9% from the same period in 1957. Revenue dropped only 1.5%, and backlog (military) is almost 75% higher. 1957's figures for same period were net income, $10,922,075.

MERGERS

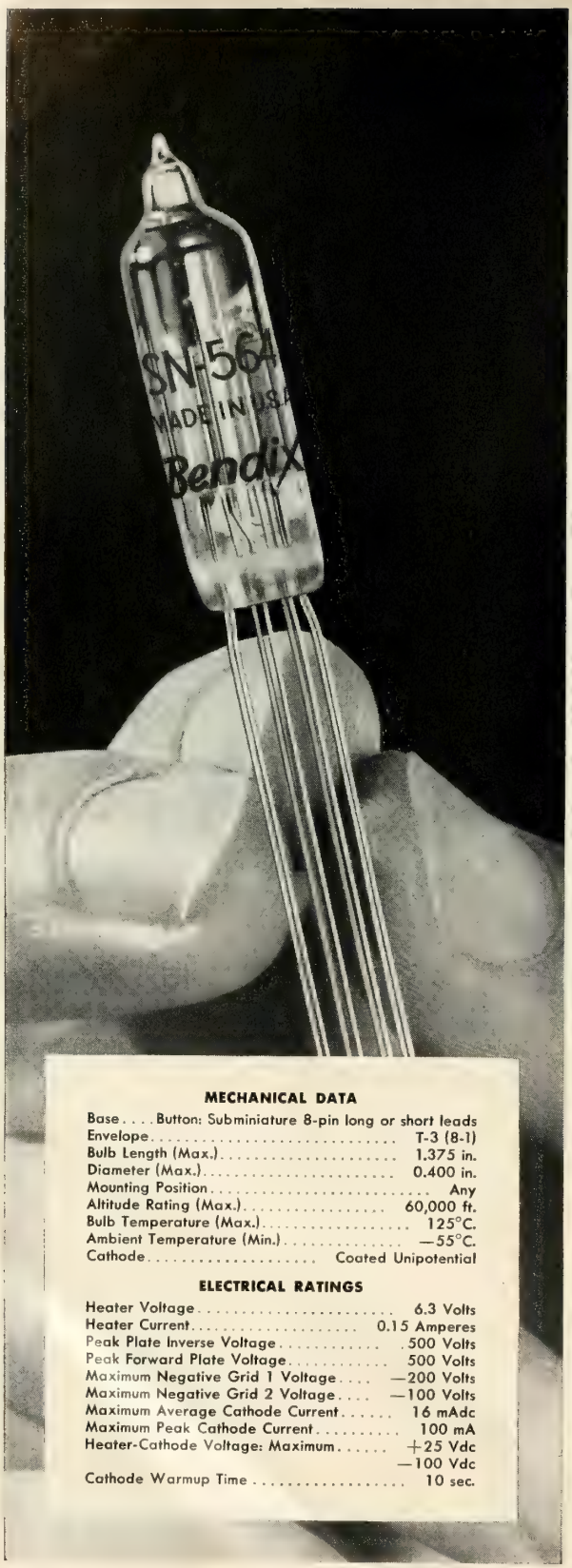
Litton Industries is losing no time in expanding recently-acquired **Airtron Inc.** First section of the expanding ferrite development and manufacturing program recently moved into a new 100,000 sq. ft. plant in Morris Plains, New Jersey. The new facility will be in full operation by the first of the year and will employ 300 people at the outset . . . **Hercules Powder Co.** announced it will build a pilot plant to make nitrogen tetroxide at Hercules, California. Nitrogen tetroxide, now used in jet fuels, is expected to find greater use in the future in liquid-fueled rockets. Initial quantities from the new plant will be available in three to four months . . . **Ryan Aeronautical Co.** announced plans to hire 300 engineers, technicians and supporting personnel at its Electronics Division new San Diego site. Plans are also in the works to expand the division's new 30,000 sq. ft. plant, occupied last fall . . . **Lockheed Missile Systems** division named Robert M. Powell as manager of the newly-established base in Hawaii. Lockheed expects to have about 60 people in Hawaii by the end of the year.

PROJECTS

Douglas Aircraft will assemble the **Southwest Research Institute**-designed prefabricated all-weather shelter for the *Thor*. The missile rests horizontally until firing time, when the shelter is rolled back on rails and the *Thor* is raised . . . And speaking of shelters, **Northrop Aircraft** is building a portable magnesium hangar for the *Snark* missile. Northrop claims that the hangar, built of magnesium for portability, is the largest structure of this material in the U.S. . . . **Because of the increased range** of the *Bomarc* 3, USAF will expand the Santa Rosa Gulf Coast Missile range out of Eglin AFB from 250 to 450 miles . . . **The Japanese Defense Agency** has established a Guided Missile Headquarters and two industry groups (**Mitsubishi** and **Fuji Precision Machinery**) are presently trying to work out a tie-up with a foreign missile manufacturer . . . In the solid propellant field, **Standard Oil of Indiana** announced that it was developing fuels for Air Force missiles that "utilize a thermo-plastic binder which permits holding the fuel at moderate temperatures into a desired shape or size." The fuel Standard is talking about will be used in an auxiliary power unit on the *Falcon*.

GOVERNMENT

On Capitol Hill, House Minority Whip Leslie Arends (R-Ill.) criticized the report on the government's research and development activity filed by the House Government Operations Committee. He labeled the report which contended, among other things, that scrimping on the part of the administration has impeded the development of advanced missiles; an attempt "to drag our eminently successful weapons programs into the dangerous arena of partisan politics" . . . **The nature of the reorganization** of ARDC is still uncertain, but the Air Council is studying the recommendations of the Stever committee and will soon submit its recommendations to General Thomas White, USAF Chief of Staff. Action is expected to be taken sometime in the fall . . . **DOD has ordered** that the three existing major test ranges will be known in the future as the Atlantic Missile Test Range (formerly AFMTC), the White Sands Missile Range and the Pacific Missile Range (including Point Mugu and Point Arguello.) . . . **Office of Defense and Civil Mobilization** issued certificates of necessity for accelerated amortization to **Lockheed Missile Systems Division** ($1,065,000 with 60% write-off) and Martin Orlando ($105,115, also with 60%). Certificates are for missile testing facilities.



MECHANICAL DATA

Base	Button: Subminiature 8-pin long or short leads
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Heater-Cathode Voltage: Maximum	+25 Vdc
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Moon Shot "Major Accomplishment": Schriever

Air Force, Army Set To Continue Programs; Handling Of LOX May Have Caused Failure

an m/r staff report

CAPE CANAVERAL — Disappointed but not discouraged, the Air Force on September 14 will fire its second lunar probe vehicle—anticipating another failure but hoping for success.

The first probe vehicle, fired August 17 at 7:18 a.m. from this missile testing center, exploded 77 seconds after blastoff.

It reached an altitude of approximately 50,000 feet. Pieces of the 52-ton rocket rained into the Atlantic Ocean 10 miles offshore at a 60-ft. depth, and many were salvaged by Navy divers for study.

Maj. Gen. Bernard Schriever, commander of the Air Force Ballistic Missile Division, theorized that a pressure leak, or a broken fuel line might have caused the explosion. He termed it a "random failure" which should have no effect on future lunar probe plans. "The shot itself is a major accomplishment," Schriever said.

The Air Force has been authorized to conduct two more probe attempts; two have been authorized for the Army Ballistic Missile Agency, with a modified *Jupiter*.

The possibility exists that the first experimental vehicle may have been loxed too early, causing a freeze and possible rupture in the first-stage engine compartment. Newsmen and observers noted that the vehicle was being "loxed" three hours before launch time. The LOX was topped off three times before ignition.

(Preliminary checks of salvaged parts, m/r learned late last week, indicated a rupture of the lower bulkhead of the LOX TANK, about nine feet above the exhaust nozzle, or of tubing in that area. It was apparent that the "contrail" most observers thought they saw just before the missile failed was actually the result of escaping liquid oxygen.)

Gen. Schriever commented that the *Thor* has had a reliability of 80%. Of the last seven fired, six traveled to full burnout. Director Roy W. Johnson of the Advanced Research Projects Agency commented that "the attempt will go down in history, even though it failed, as the Kitty Hawk of the missile business."

• Quick action—The lunar probe project was one of quick organization. Part of the IGY program, it started on March 27 when Defense Secretary Neil H. McElroy ordered the Advanced Research Projects Agency to take program cognizance. In 12 days, ARPA ordered the Air Force Ballistic Missile Division of ARDC to conduct three lunar probes. The Army Ballistic Missile Agency was ordered to make two probes, and the Navy was assigned the task of developing a mechanical ground scanning system at its Ordnance Test Center, Inyokern, Calif.

The Air Force had emphasized that the *Thor* still is essentially an R&D vehicle and that the first flight test of all components probably would fail. Objectives of first test flight were:

To achieve proper powered flight performance from all three stages; to reach escape velocity from the earth's gravitational field; obtain data during the 250,000 mile flight; and finally, achieve trajectory control sufficient to place the payload in the vicinity (50,000 miles) of the Moon. Complete success depended on the perfect functioning of more than 300,000 complex and interdependent parts.

These are the questions which will be answered eventually through moon rocket research.

• Configuration, elements—The Air Force's lunar probe vehicle configuration had a total height of 88.1 ft. The first stage was a standard *Thor*, numbered 127, weighing more than 100,000 lb. and developing a thrust in excess of 150,000 lb. It had an 8-ft. diameter.

Second stage was powered by an Aerojet-General Corp. 1040 liquid-fueled engine of 7,500 lbs. thrust. This configuration was changed with the addition of eight spin, or vernier rockets.

The third stage, developed by Allegany Ballistics Laboratory as part of the *Vanguard* series, but never used, had a 2,500 lb. thrust engine. This 400 lb. (weight) stage and its payload were covered by a nose fairing which was to have been jettisoned after first and

Four M/R editors were on the scene at Cape Canaveral to bring this story and pictures to readers. Editor Erik Bergaust; Associate Editor Norman L. Baker; Assistant Editors Donald E. Perry and Frank McGuire collaborated on this report.



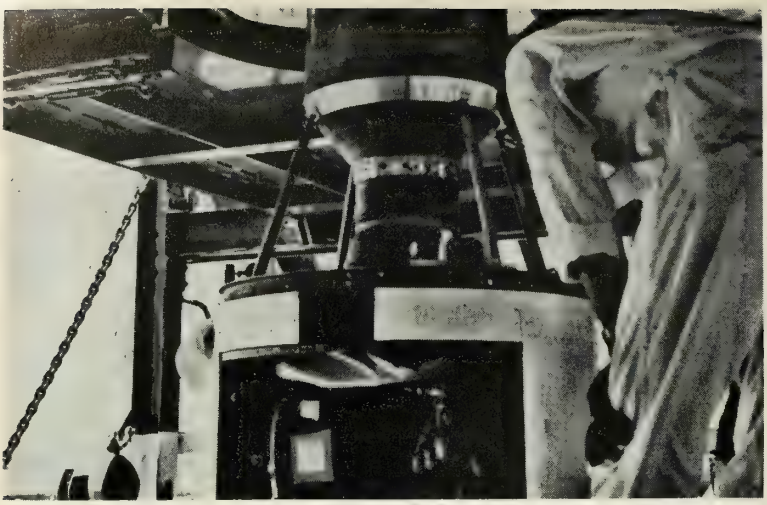
ROY W. JOHNSON . . . "the attempt will go down in history with Kitty Hawk."



GEN. SCHRIEVER . . . "the fact . . . it got off is a major accomplishment."



MAJ. GEN. D. N. YATES . . . "we are disappointed, but not discouraged."



MATING SEQUENCE for Moon Rocket. Here, second and third stages go together.



SECOND STAGE comes into position for joining with Primary Stage of *Thor*.



FINAL ADJUSTMENTS are completed on mated first and second stages of missile.

second stage separation occurred.

A Thiokol solid propellant terminal rocket of 3,000 lb. thrust was the basis of the payload package. The 83.8 lb. package contained 25 lb. of instrumentation weight, including batteries with a one-month life expectancy, a telemetry system and the NOTS photo-electric cell scanning device. Telemetry measurements would have included the measurement of the number of meteorite impacts, magnetic field, and the thrust-chamber pressure of the terminal rocket, giving evidence of whether or not it fired successfully in the planned 2.6 day flight.

• **Contractors**—West Coast industries played a prominent part in assisting Space Technology Laboratories of Los Angeles in the Air Force probe attempt. STL had over-all technical direction and systems engineering responsibility for the project, plus hardware responsibility for the second and third stages and the scientific payload of the vehicles.

Among principal subcontractors were: Atlantic Research Corp., Summit Industries, Pacific Automation Products, Rantec Corp., Western Electric, Reeves Instrument Corp., Radio Corp. of America, and Hallamore Electronics. A total of some 52 firms were involved.

Here is the contractual breakdown:

First Stage: Vehicle: Douglas aircraft *Thor* IRBM; Propulsion: Rocketdyne (first production engine by Neosho); frame, control, instrumentation and electrical systems, Douglas; Checkout, assembly, integration, Douglas.

Second stage: Propulsion system and tanks: Aerojet-General Corp.; Electrical, control, instrumentation, assembly and integration, spin rocket systems, STL.

Third stage: Rocket motor, Allegany Ballistics Laboratory; structure, electrical, assembly, integration and checkout, STL.

Terminal vehicle—Overall responsibility, STL; scanner and transmitter, Naval Ordnance Test Center, Inyokern; Thiokol Rocket Motor.

Major ground stations which would have been used for tracking are at Cape Canaveral; Singapore; Hawaii; the Manchester, England radio telescope antenna, and the Lincoln Laboratory, Millstone, N.H.

Nine naval minitrack stations were to have assisted. Data received was to have been transmitted on a special teletype circuit to the AFBMD Communications Center, where a staff of 40 people, headed by Lt. Col. Donald Latham and Dr. G. E. Mueller of STL, would make evaluations.

Mars, Venus: Next on U.S. Schedule?

CAPE CANAVERAL—ARPA director Roy W. Johnson confirmed at a press conference here that the U.S. will undertake a program for sending probes to Mars and Venus. Johnson said the program will be conducted by NASA. He did not elaborate and did not offer any details.

Missile experts visiting here for the first lunar shoot said the Mars and Venus probes probably will use IRBM boosters and be similar to the current Air Force and Army lunar vehicles. A check with NACA indicates "Mars and Venus probes are being considered," but that a program will not get underway until after NASA has been fully established.

DOD and Air Force have been flooded with Mars and Venus probe proposals. One official said the U.S. program for probes to the planets "is being hampered by politics, in that the agency that is to take charge has not been set up yet." Another official speculated it will take as long as one full year before NASA will authorize a program "although Mars probes could be incorporated as a follow-up series of the current lunar probe programs."

Army's Dr. Ernst Stuhlinger previously told m/r a Mars probe would differ from a lunar probe in payload design. Batteries must be designed to trigger the instruments after the vehicle has traveled for some 259 days. "This means more reliable and somewhat more complex instrumentation, but we know how to do it and we can do it now," he pointed out.

Newest *Explorer*, No. 5 Readied For Launching

Next space probe attempt will be *Explorer* V, in countdown as m/r went to press. Launching time is scheduled for 2 AM, Thursday, August 21st. *Explorer* V is the second of two satellites authorized last May to probe the intense radiation band discovered by earlier satellites. According to Army sources, it will be identical to *Explorer* IV and will carry the same instrumentation, designed by Dr. James Van Allen of the U. of Iowa.

However, any mishap in launching that results in a faulty orbit such as that of *Explorer* III would probably be welcomed by scientists. This might make it possible to determine the upper limit of the x-ray band, because a faulty orbit would likely have a vastly higher apogee than an ideal orbit.

While Army preparations were concluding, on a nearby pad the next *Vanguard* vehicle was being prepared for launching. This *Vanguard* will carry the "Weather Eye" infra-red scanning system.

Doolittle Named Chairman Space Tech. Laboratories

The Ramo-Wooldridge Corporation has announced that, effective January 1, General James H. Doolittle will become Chairman of the Board of Directors of the Space Technology Laboratories. Previously a division of Ramo-Wooldridge, the Laboratories on January 1st will become a separate corporation with an independent Board of Directors.

Space Technology Laboratories is the Ramo-Wooldridge division that has over-all scientific responsibility for the Air Force's *Thor, Atlas, Titan,* and *Minuteman* missile programs.

General Doolittle, who is now serving in a number of government advisory posts, including chairmanship of NACA and chairmanship of the Air Force's Scientific Advisory Board, will continue as a member of the Board of Directors of Shell Oil Company, but he will retire as vice-president of that organization at the end of the year, it was announced.

Ford Instrument to Design No-Gimbal Guide System

The Weapons Guidance Laboratory at Wright Air Development Center has awarded a contract for the development of a radically new type of inertial guidance system to the Ford Instrument Company division of Sperry Rand, it was announced recently.

The Phase I portion of the contract is for the study and preliminary design of a "No-Gimbal Pure Inertial Guidance System." This is a system which uses gyros fixed to the vehicle frame and computes deviations of the vehicle to give an unvarying space-fixed base to the measuring accelerometers.

Ford Instrument has been working on this type of system for some years, but found that the state of the analog computer art in the past precluded a successful system. The system now under development will undoubtedly use a digital computer to convert gyro-sensed deviations to proper orientation signals for the accelerometers.

The elimination of stable platform gimbaling coupled with the reliability and repeatability of digital techniques promises a vastly simplified and much more reliable inertial reference and measuring system.

Congress Hits Procurement Practices

For the third time in five years, House investigators have dug into the procurement of launchers of air-borne rockets of the Air Force and Navy. In brief, the Committee on Government Operations found little it liked and specifically scored the Air Force and Navy procurement offices, and the Small Business Administration.

The committee, which in 1953 and 1954 (as the Investigating Sub-committee on Defense Activities) looked into the subject, termed planning for procurement "markedly poor," and said the imbalance between launchers and rockets now and for the past several years impairs the nation's aircraft firepower capabilities in the event of an emergency.

Military spokesmen declined comment on the report, released this week, but they admitted the situation was not good. One Air Force office said that present stocks of rocket launchers leave much to be desired, but that there are enough on hand to meet current requirements.

The Navy agreed improvement is needed in many areas, however, Navy officials disagreed with the Committee report that only 13,391 of the 19-round Aero 7D launchers had been shipped by mid-July. To date, the Navy has accepted delivery of some 18,000 for operational use, with the remaining 26,000 to be delivered by January, 1959.

The Committee said the congressional intent to help small business "is partly nullified by administrative procedures which permit subcontracting by small business to big business" and that "The Small Business Administration showed itself to be poorly informed and inconsistent with regard to positions taken within its own organization, when this matter was called to the agency's attention."

Among other matters, the Committee recommended that the Air Force and the Navy establish firm requirements, integrate procurement, and take steps to assure production sources adequate to fulfill these requirements.

Congressmen further urged that steps be taken, in cooperation with the Small Business Agency, to prevent subcontracting by small business to big business where procurement has been exclusively reserved for small business; prohibit 100% contracting unless clearly authorized in advance; and prohibit transfer of contract or subcontract for fees or commissions paid for such transfers.

Red Moon Stunt Seen Likely



Leroy Corcoran

SOVIET man-in-space capsule based on a drawing in "Red Star" newspaper.

As m/r went to press, speculation was that Red space scientists were preparing a moon probe or a man-in-space capsule program. Launching might coincide with the opening of the Ninth Congress of the International Astronautical Federation at Amsterdam, Holland, August 25-30.

Last year's congress in Barcelona was opened with the news of *Sputnik* I, and the hero of the congress was Dr. Leonid I. Sedov, who headed the four-man Russian delegation.

In an exclusive interview with m/r during the Congress (November 1957), the Red delegation outlined Russia's moon program:

The first Red moon rocket may carry a payload of approximately 500 pounds and be designed to either hit the moon or enter into an orbit around that satellite. The second lunar vehicle will be designed to retard its fall by means of reverse-thrust rockets, and plant itself and its instrumentation on the moon.

A third type of lunar probe will carry television equipment to relay back-to-earth closeups of the moon's surface. And a fourth type may carry a live passenger—animal or man—if the previous rockets and probes have been successful, and if the information gathered has been satisfactory enough to encourage manned trips into space.

The accompanying cross-sectional view of a capsule to put man into space (left) was recently shown in the Russian Army's newspaper RED STAR. The capsule, which is very similar to the one planned for use in the United States Army's Project Adam, contains: 1) air intake; 2) oxygen control panel; 3) oxygen and pressurization equipment; 4) carbon dioxide absorber; 5) electronic instruments; 6) radio receiver; 7) water supply; and 8) electric batteries.

Boeing's "Dyna-Soar" To Use Pinpoint

Goodyear Aircraft Division—already in the "Dyna-Soar" project as a member of the Martin-Bell team—last week was awarded a contract by the prime contractor of the competing team, Boeing Airplane Co. Under the contract, GAC will produce PINPOINT guidance systems. PINPOINT combines map-matching and inertial guidance principles.

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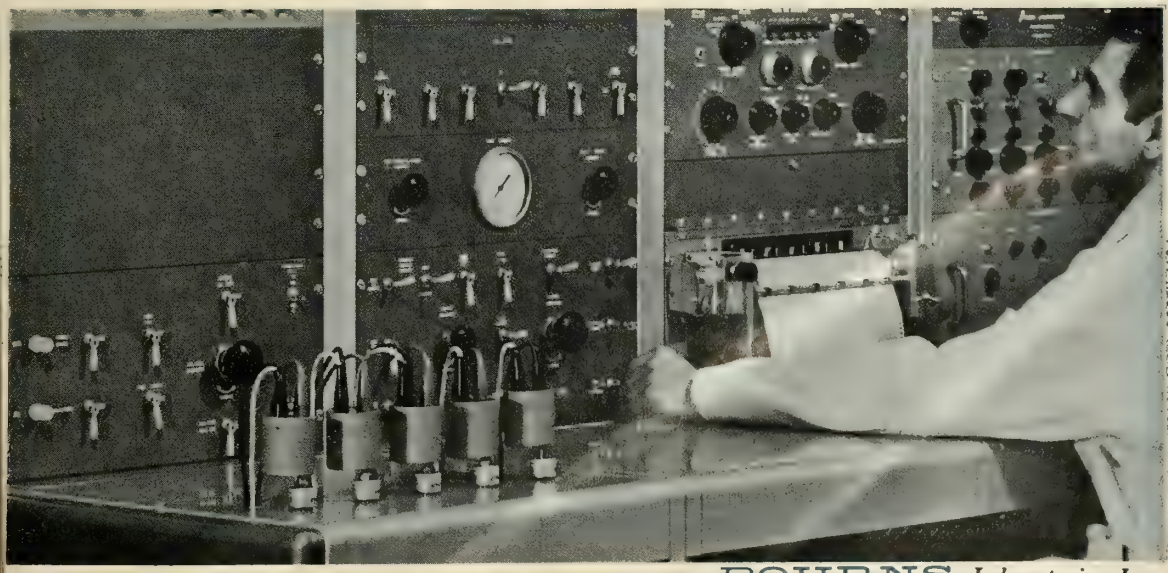
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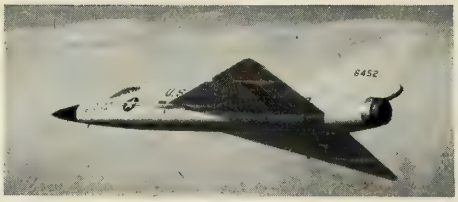
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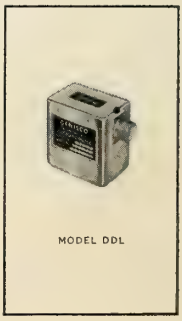
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SEPTEMBER

Summer Program, Problems of High-Powered Radar Design, Massachusetts Institute of Technology, Cambridge, Mass. (Security clearance required) Sept. 2-12.

1958 Cryogenic Engineering Conference, Massachusetts Institute of Technology, Cambridge, Mass., Sept. 3-5.

American Rocket Society, Fall Meeting, Hotel Statler, Detroit, Mich., Sept. 15-18.

13th Annual Instrument Automation Conference, Convention Hall, Philadelphia, Pa., Sept. 15-19.

ASQC, 5th Annual San Francisco Bay Area Conference, Stanford University, Palo Alto, Calif., Sept. 19.

Professional Group on Telemetry and Remote Control, 1958 meeting, American Hotel, Bal Harbor, Miami Beach, Fla., Sept. 22-24.

Standards Engineers Society, Seventh Annual Meeting, Franklin Hotel, Philadelphia, Pa., Sept. 22-24.

Air Force Association, Airpower Showcase, Dallas, Texas, Sept. 25-28.

ASME Power Conference, Statler Hotel, Boston, Mass., Sept. 28-Oct. 1.

OCTOBER

Armour Research Foundation and Illinois Institute of Technology, Annual Noise Abatement Symposium, Hotel Sherman, Chicago, Ill., Oct. 9-10.

Fuels-AIME Conference, American Society of Mechanical Engineers, Old Point Comfort, Va., Oct. 9-10.

ASME, Lubrication-ASLE Conference, Statler Hotel, Los Angeles, Calif., Oct. 14-16.

Association of the United States Army, 1958 annual meeting, Sheraton-Park Hotel, Washington, D.C., Oct. 20-22.

Fourth Annual Symposium on Aviation Medicine, Miramar Hotel, Santa Monica, Calif., Oct. 22-24.

SAMA Laboratory Apparatus and Optical Sections' Midyear Meeting, Westchester Country Club, Rye, N.Y., Oct. 26-28.

1958 National Metal Exposition and Congress, American Society for Metals, Public Auditorium, Cleveland, Ohio, Oct. 27-31.

Institute of Radio Engineers East Coast Conference, Aeronautical & Navigational Electronics, Lord Baltimore Hotel, Baltimore, Md., Oct. 27-28.

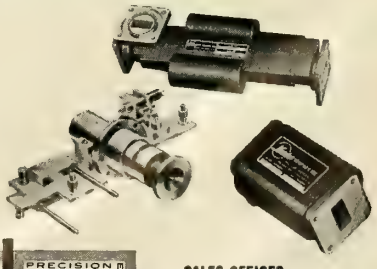
IRE, 1958 Electronic Devices Meeting, Shoreham Hotel, Washington, D.C., Oct. 30-31.



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Vandenberg . .

With a Brand-New Name, Former Cooke AFB Gets Ready For a New Role



THE MOUTH of the flame deflector of the first *Thor* launching pad. The second pad of the two-pad complex can be seen in the background.



WORKMEN SNAKE propellant flow pipes into position on *Atlas* launching stand. Pipe will connect missile with storage tanks under stand. Pad shown is 90% complete.



FRAMED IN THE MAMMOTH lip of an *Atlas* flame deflector plate, workmen drill water flow holes for cooling the steel during hot firings. Water flow capacity—18,000 g/m.

pace Base, U.S.A.

By Norman L. Baker

VANDENBERG AFB, CALIF. — The United States' first and largest combined training-operational long range missile base has taken its first functional steps, while construction programs continue.

A contingent of 50 Royal Air Force personnel were enrolled as Vandenberg's first trainees on August 15. Slated to receive group training on the *Thor*, they will form the operational vanguard for the initial IRBM deliveries slated for the end of 1958. Earlier, the group received individual training in the fabrication and testing of the missile systems.

No time is being lost between facilities acceptance and the initiation of the training program. Two *Thor* launch complexes have been accepted by the Air Force and are currently being made ready for use. The first *Thor* training missile was delivered to the base Aug. 13, others will come during the first week of September, on the heels of *Atlas* trainers. One *Atlas* was delivered on July 1 to serve as a launch pad compatability checkout unit as well as a training tool.

• **Surpasses Canaveral**—Vandenberg (formerly Cooke AFB), will be the largest, most elaborate and fully equipped missile base in the United States when completed.

Within months, the broad expanse of the base's 64,000 acres will be crisscrossed with a dense array of launch pads for the entire arsenal of U.S. long range missiles.

In addition, there will be control centers, tank farms, assembly shops, classrooms, housing areas, an airfield, and ground tracking stations.

If any base, now or in the near future, deserves to be tagged "space port," it should be Vandenberg.

Air Force says that Vandenberg, at least for the time being, will serve only as a training and operational readiness base, and will not absorb any of Cape Canaveral's research and development testing program. Officials pointed out to m/r that Vandenberg's location (proximity to missile contractors in southern California and optimum launching capabilities) will make it ideal for a future R&D center.

• **Ideal location**—Almost the entire base is situated on Burton Mesa, a flat tableland—217 feet above sea level—nestled between two mountain ranges, sloping gradually to an isolated beach, sand dunes and brush. The nearest community, Lompoc, lies eight miles to the southeast. Only the Southern Pacific railroad, running north and south along the beach, invades the isolation of the area.

The launching pads are dispersed along the beach, jutting out into the ocean to provide an unobstructed missile flight lane.

If desired, missiles could be fired due south without endangering populated areas. This was the primary reason for the selection of Vandenberg as the take-off point for a polar-orbiting reconnaissance satellite. The orientation of the pads now under construction indicate that most flights will be made in a SW to SSW direction. (Any flights to the south will describe a path over the Navy's 20,000 acre Pt. Arguello Pacific Test Range, now under construction.)

As for security during launchings, "beachwatchers"—a headache for the AF at Cape Canaveral—are at a disadvantage at Vandenberg. The closest point where off-base observers could see a missile on the pad is more than 10 miles away. Only a railroad line, which had to be accepted with the base, could present a problem.

• **Launching pads**—The number of launching pads completed, under construction, and planned is of such magnitude as to make the Cape Canaveral personnel justifiably envious.

The pads are laid out in integrated complexes for control from central blockhouses. While at Cape Canaveral the pads are in a single line along the beach, at Vandenberg they are positioned along the beach and inland in what at first glance seems a haphazard pattern of two- and three-unit groups (see map, p. 23).

Missiles that will be launched from the base include *Thor, Jupiter, Atlas, Titan,* and *Bomarc.*

Pads for the *Thor* are the nearest to completion; seven are under construction, ranging from 85% to 100% complete (there are three *Thor* pads at Cape Canaveral). The first two, less the gantrys, were completed and accepted during July. The *Thor* pads are arranged in pairs, approximately 500 yards apart, with the control center blockhouse midway between them.

Six *Atlas* launching pads are under construction—three of these are 90% complete. The other three are weeks away—the first ground for these was broken in July. The *Atlas* pads are arranged in a triangle with a single blockhouse positioned in the center.

The *Thor* and *Atlas* positions are described as "soft" (located above ground level). Each pad is equipped with everything needed for individual operation: the *Atlas* pads, which have their missile mounting surfaces located flush with ground level, could handle two missile firings without re-supply.

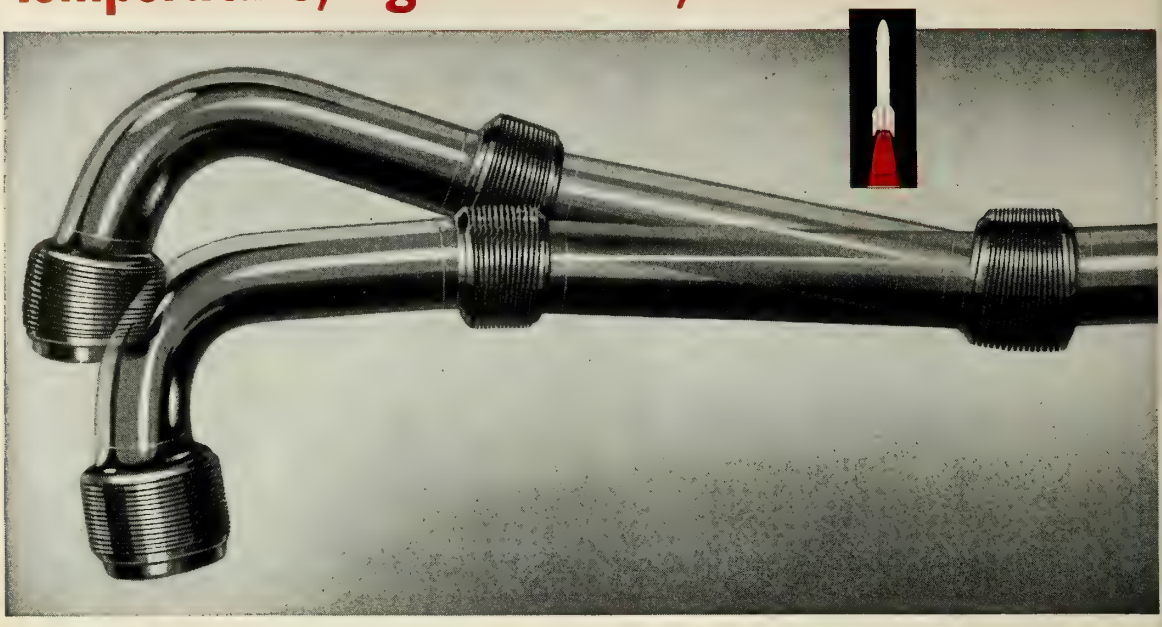
In rooms below the *Atlas* stands, separated by a few feet of concrete, is the fueling system and liquid oxygen supply (28,000 gallons), nitrogen storage, electrical power units, and a crew safety area. The whole area is completely air-conditioned. The missile's rocket engine exhaust will be deflected by a 90 degree blast-plate, cooled by a water flow having a capacity of 18,000 gpm. The rocket's flame and deflector coolant will be carried away to the sea in deep ditches.

The *Atlas* pads will serve the dual



WELDER IS APPLYING finishing touches to the rails that will guide the huge servicing gantry handling the *Atlas*.

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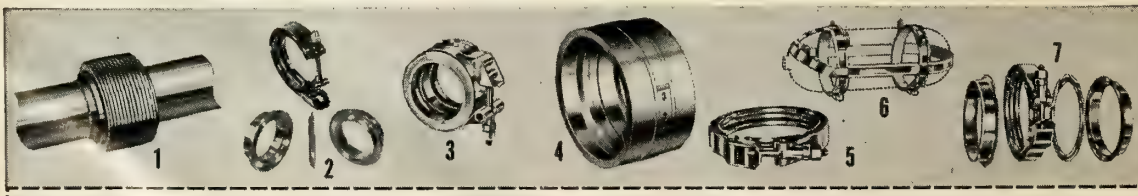
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purpose of training crews and as standby operational retaliation units. Land has been set-aside for future expansion of the *Atlas* program.

The *Thor* and *Atlas* pads are currently the only ones under construction. The sites for the *Titan* training and operational launch pads have been surveyed, on beach land north of the mesa, and may include about nine pads. Although the site has been selected for *Jupiter* units, the Air Force reported that no work has been started.

A short distance inland from the *Atlas* launch stands is the missile's guidance control system. The control building overlooks all the stands—a requirement for the radio inertial system. The guidance system consists of the control building, and two "legs" containing wave guide cables arranged in a cross shape.

• **Support facilities**—Located approximately seven miles east of the launching area are the barracks, mess halls, classrooms, and housing units for the Air Force personnel. Here, in what was Camp Cooke, the Army base of World War II, another large construction program is underway. About $10 million of the present $45 million construction contract will be utilized for houses, new buildings, and remodeling of old barracks. Total construction cost will exceed $100 million. Only about two-thirds of the old camp is being used (northern portion)—with no plans for the remainder.

New construction includes an *Atlas* and *Thor* assembly building (now completed), an 8,500-ft support runway and 1,430 three-to-four bedroom houses. Near the runway, a *Bomarc* surface-to-air missile base will be constructed for defense of the base.

Future missilemen on duty at Vandenberg will live under conditions not even dreamed of by service men of the past. The old, two-story 63-man Army barracks are being converted into 35-man units separated into two-man rooms. Floors are tiled and flush doors are used throughout. Bathrooms are completely modern, with individual stalls for showers and toilets.

There will be three 1,000-man mess halls with cafeteria-type service. Plans are being laid for a family-style service for the near future. A "hobby" garage where personnel can repair automobiles has been planned. For recreation, there will be swimming pools, a 1,000-man theatre (under construction), and a gymnasium (completed).

• **Training program**—All personnel training at Vandenberg will be in the



THE MISSILE launching location of Vandenberg AFB can be seen in the above map.



LAYOUT OF Vandenberg AFB showing location of missile launching pads.


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group training category, referred to as the Integrated Weapon Systems Training. Officers and airmen will first receive individual training on all the various missile components at contractor plants. This training, which varies from three weeks to six months, will include such areas as nose cone (arming, fusing, assembly), guidance (missile and ground station), fueling, LOX handling, rocket engine check out, launching, ground support, and general electronics.

Upon arrival at Vandenberg, individuals will be formed into integrated groups for the IWS training. Group crew training will take three to four months. The crew will be taught assembly; handling; maintenance of the missile and its component parts; transporting and erecting; and finally, actual countdown and static-firing. After a few of the classes have completed the course, one class will be selected to carry through an actual flight operation.

Classes will be conducted on a mass lecture basis with an anticipated 2,000 to a class. A *Thor* squadron will contain 500 men, 65% of whom will be technical personnel. How many of the technical personnel of each squadron that will be trained at Vandenberg was not disclosed.

The Air Force hopes to start classes in individual training at Vandenberg as soon as it is feasible, although officials admit it will be impractical for many months to come.

Contractor-instructors will be employed for crew training until a sufficient number of Air Force personnel have been trained for the task. Many of the first students will be retained at Vandenberg to assist the contractors in the training program.

As the crews are trained, they will be dispatched to bases. At predetermined intervals, crews will be returned to the school for further actual flight shots. Crew training on the *Atlas* is not expected to get underway until the fall of 1959.

The 704th strategic Missile Wing, under the command of Col. William S. Radar, will conduct the IRBM and ICBM training program. This unit will also provide, operate and maintain instrumentation necessary for the missile training launches. The 704th is under the control of the 1st Missile Division, commanded by Maj. Gen. David Wade, formerly Chief of Staff, SAC Hdqs.

The division, with headquarters at Vandenberg, will incorporate under one central control all ballistic missiles designed for strategic operations. In addition to the 704th, the 706th Wing (*Atlas*) has been activated at Warren AFB, Wyo. The Air Force has identified three IRBM and two ICBM squadrons in various stages of the training program.

The 392nd (*Thor*) will be stationed at Vandenberg as training personnel; the 864th and 865th (*Jupiter*) are being trained by the Army at Redstone Arsenal as operational strategic missile squadrons. The 394th (*Atlas*) squadron will train crews at Vandenberg with the 576th (*Atlas*) programmed as the first operational crew.

• **Housing bottleneck**—Finding quarters for personnel and their dependents is currently a major problem. The Air Force is engaged in an accelerated housing development program, but the most conservative estimates indicate that it will be extremely inadequate.

A $11-million on-base Capehart development of 880 three and four bedroom individual homes was started in September 1957, with most units to be completed by this September. A second installation of 525 Capehart units at a cost of $7,765,913 was started July 1. Yet, there are over 700 Air Force personnel in need of homes for their dependents. To make matters worse, it is estimated that about 3,500 off-base houses will be needed for Air Force and contractor personnel by the end of 1959.

The Air Force admits freely that this housing can be obtained only by an all-out effort by the people of the communities of Lompoc and Santa Maria. Construction by these towns has so far been very gradual and marked with hesitancy. There is need for an education program—to convince the local populace that the Vandenberg base is not of a temporary nature—as was the case of Camp Cooke during World War II.

• **Flower seed center** — Lompoc, situated in the "Valley of Flowers," extends from the mountains to the sea, and has only 260 houses and approximately 20 two-floor apartments under construction. Present construction is limited within the town's limits. The Air Force, in an effort to offset part of the problem, has established a permanent house trailer camp on the base.

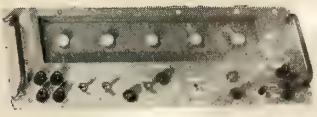
Lompoc, the future Cocoa of California, with a population of 6,665, is looking forward to a tremendous growth—some believe it will blossom into a city of 40-50,000 within the next few years. The annual income is approximately $9 million, with $5.5 million as a result of its wide range of agriculture. Industrial income is derived from earth processing plants.

Lompoc is only a short drive from fresh water lakes in the mountains on the east, to the ocean beaches on the west. There are eight county parks in the area, affording recreation for all summer sports. Climate conditions are excellent—average temperature 63 degrees, lowest average 52 degrees, combined with an average rainfall of 13.5 inches.

Santa Barbara is slightly over an hour's drive south; Los Angeles about 4 hours away.★

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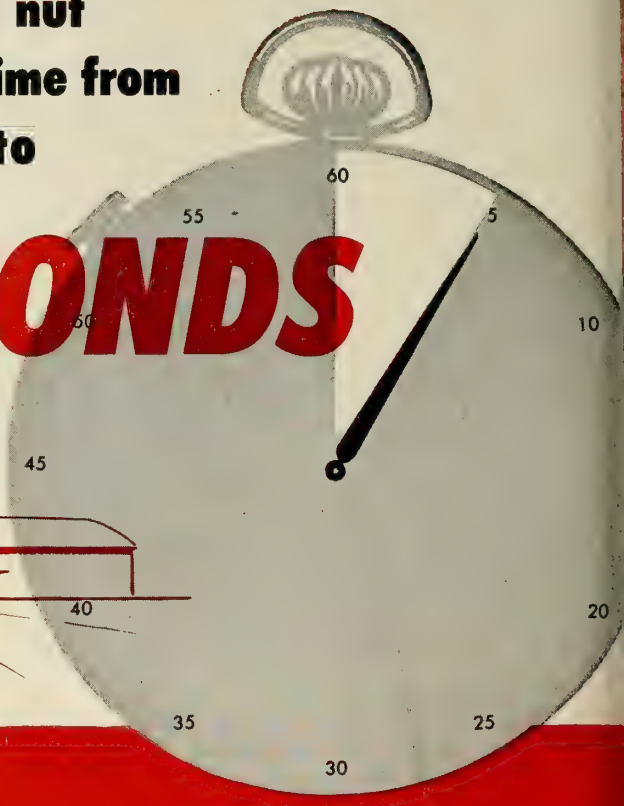
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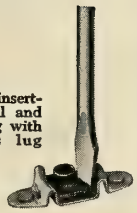
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Missile Electronics Growth Important to Florida Economy

by Donald E. Perry

TALLAHASSEE—Missile electronics research and manufacturing in Florida is not confined to the Cape Canaveral area—the whole playground state is now at work.

There is stepped-up activity all over the Sunshine state. It now has more than 100 electronics manufacturing firms, with total emplyoment of more than 10,000, and an annual payroll in excess of $40 million. In the past three years, electronics manufacturing has more than tripled in both the number of plants and total employment, and the Florida Development Commission estimates it is a $150 million-a-year industry.

Although the state's biggest plant, the 3,800-employee Martin Co. in Orlando, is turning out four major weapon systems; a three-engineer outfit in Melbourne—Missileonics—is hard at work designing and developing doppler systems for the big missile names at the Cape.

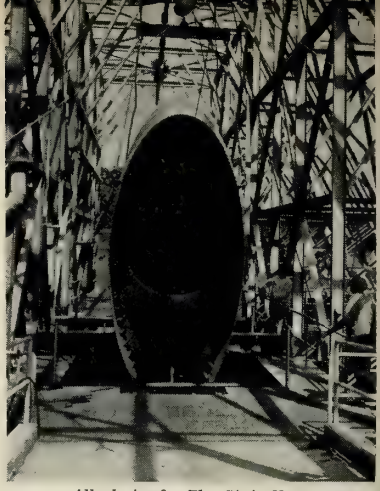
A map of Florida today shows the location of plants from Fort Walton Beach and Eglin Field in the west panhandle, down through the missile country of Orange and Brevard Counties, into the aviation centers around Fort Lauderdale, Orlando and Miami.

At Panama City, a Navy lab tries out electronic countermeasures against mines and torpedoes in the Gulf of Mexico. In Orlando, sonar research is carried out in the waters of a 35-foot crystal-clear lake for application to submarine missiles. At Miami, an engineer-group shipbuilding corporation is field-testing an electronic auto-pilot for hydrofoil boats.

Florida electronics manufacturing embraces every category of the industry. Electronics for aircraft is the major concern of 16 companies; marine communications, six; missile tracking and computing, 10; and industrial control and instrumentation, six. Other firms specialize in components.

Six plants are in the countermeasures field—including the Kett Technical Center infra-red laboratory at Pompano Beach and the fast-growing telemetry firm of Radiation, Inc. at Melbourne. Radiation, Inc., which several months ago set up an astrionics section, now reports it is the second largest part of the company.

• **Civilian contracts**—While about 80% of all Florida electronics activity is geared to defense contracts, many firms are producing items for civilian use, and others says they could convert to non-military production without too much difficulty. As an example, Centronix of Coca, while heavily involved in engineering work at the missile test center, is also making equipment for commercial radio stations and the Civil Aeronautics Administration.



All photos by Fla. State News Bureau

SONAR DOME is lowered into lake by Navy's Underwater Sound Reference Lab.

The Kett center, which opened in January, eventually will have a $2 million annual payroll. Studies underway in campus-like buildings on a 25-acre site include research on supersonic and transonic propellers and atomic reactor tools.

Electronics Communications' environmental laboratory at St. Petersburg deals with accelerations up to 75 Gs and altitudes up to 150,000 feet. The company also makes data link receivers, flap actuators, and electronic facsimile systems. Vice-president Tom F. Grieser pointed out that not only had his company added $5 million this year to its existing $12 million component contract for Hughes Aircraft Co., but that the company will start a new 150,000-square foot factory building by the end of this year. The firm already has two plants in the area.

Three other electronics industries are on the West coast near St. Petersburg. Recently opened was the Sperry Microwave Electronics Division at Oldsmar on an 80-acre site.

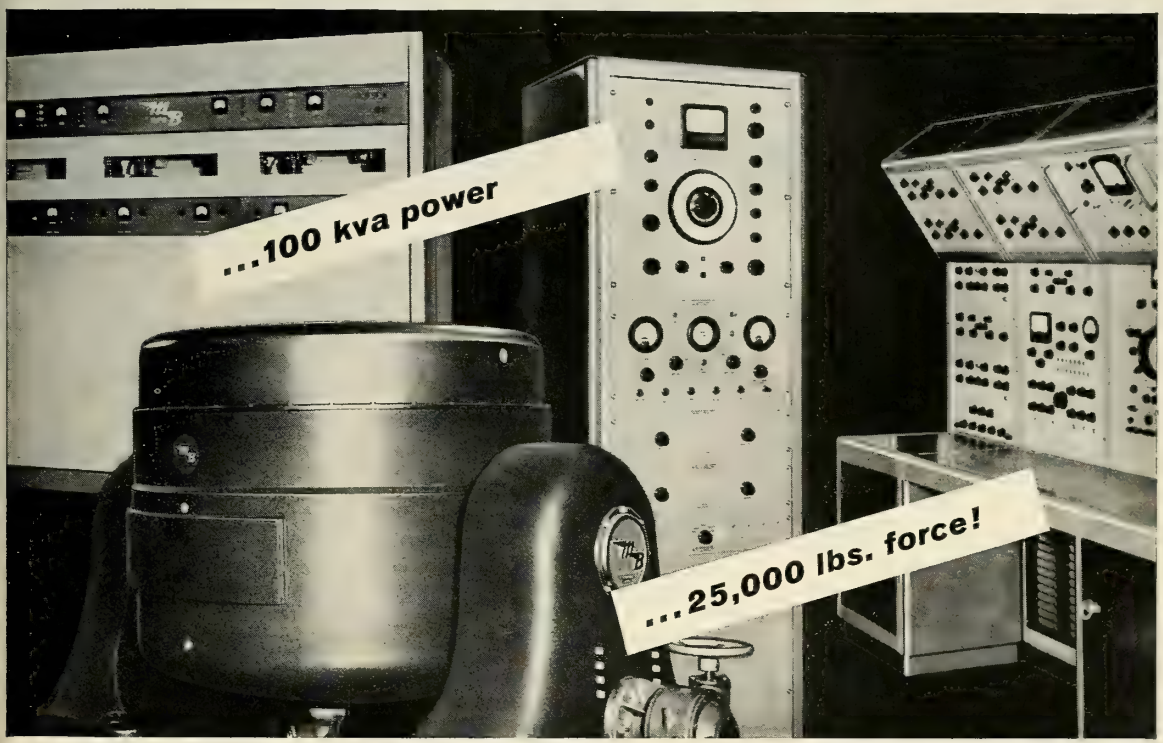
General Electric, which plans to add 200 employees at its Pinellas Peninsula Plant, has been in operation for two years turning out classified devices for the Atomic Energy Commission. The $2.5 million Minneapolis-Honeywell plant, in the same area, has an inertial guidance engineering center which is the first installation in the country exclusively devoted to prototype and production work on hermetic integra-



ELECTRONICS research and manufacturing is not confined to the Cape Canaveral area.

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MINNEAPOLIS-HONEYWELL'S gyroscope and inertial guidance facility—surrounded by a moat to minimize vibration.

ting gyroscopes and accelerometers. Manager Melvin Fedders comments "we are still growing and adding to our staff."

Sperry also has an Electronic Tube Division at Gainesville, where klystron tubes have been produced since 1955. The plant soon will hire 200 more employees, and is moving part of its operation into a new 36,000 square foot building.

Biggest of the Melbourne area firms is Radiation, Inc., which started in 1950 with two engineers, Homer Denius and George Shaw. They staked a $25,000 bankroll on the chance that a combine of telementry and data system specialists could succeed in a state which had little related activity. Today, Radiation has 710 technicians and engineers; 135,000 square feet of floor space; two aircraft landing strips; and $8 million in contracts.

• **Smallest to biggest**—At the other end of the spectrum in Florida companies is Missileonics, with three engineers brain-storming in 6,000 square feet of abandoned hangar space at Melbourne airport. Here, president James Coapman, Frank Perkins, and William Thomas have designed and developed 12 vans of doppler beat systems now in use at the Cape, and have just come up with a 28 channel pulse amplitude modulation (PAM) telemetry decommutation system.

Jobs created by missile and electronics expansion have been a big factor in helping Florida to weather the national recession. Typical comments include:

"Our total business in the last nine months is greater than all previous work since we started in 1955," according to William Rose, general manager of Milgo Electronic Corp. in Miami. Rose called the $1.7 million in contracts now being worked by his data system firm a "Cinderella story," and said company expanison was "two years" ahead of first plans.

Ben Moss, production manager for Orlando's Systems, Inc., a research and development firm, said, "We just got through doubling our space. This addition to the building was ahead of schedule and business seems ahead of last year."

Frederick Macklin, sales manager of Communications Company in Coral Gables, said "work has increased considerably, and we're working on two new radio equipment contracts for the Coast Guard and the Navy."

From Airpax Products, components manufacturer in Ft. Lauderdale which opened a new Seminole Division plant last year, came the comment: "We're ahead of last year and the prospects are very bright."

Actually, Florida led the entire country in manufacturing employment increases during 1957, both numerically and in percentage. Only five states showed increases for the year, with 40 states showing losses and three reporting no significant change at the present time.

Employment in eight of Florida's biggest companies increased by 1,695 in April, May, and June; and three firms reported their expansion programs were ahead of schedules that were previously planned.

U.S. Department of Labor figures show that the country as a whole had a 1957 decline of 4.9% in manufacturing employment, while Florida had a 5.5% increase for the same year in manufacturing.★



THE TELEMETRY and data processing lab of Electro-Mechanical Research, Inc.

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ARTICULATE AND DEDICATED to his science, Dr. Strughold can hold any audience as he discusses his latest efforts.

Space Doctor Seeks Survival Solution

by Erica Cromley

"If industry were to come up with a workable space craft, man could now survive several weeks in space. The biochemical means exist."

This assertion was made recently by Dr. Hubertus Strughold, advisor for research at the Air Force's School of Aviation Medicine (SAM), and the man mainly responsible for the biologist's lead over the engineer in efforts to put man into space.

Although the closed ecolgical system which Dr. Strughold envisages is still some years away, a two or three-week space journey today would not require anything in the way of radical equipment. Canned food, oxygen tanks, chemical carbon dioxide absorbers and chemical waste disposers would meet essential biological requirements for short-term space voyages.

The closed cabin in which Airman Donald Farrell lived for a week, and which SAM obtained in 1954 largely through Dr. Strughold's efforts, was thus equipped.

Experiments conducted by Dr. Strughold, both in wartime Berlin as head of the Aeromedical Research Institute and later when he directed SAM's Division of Space Medicine at Randolph Air Force Base, Texas, show that man can stand the stresses of the extreme acceleration and deceleration going out of and re-entering the atmosphere.

"As early as World War II, we had shown that a man could survive 15 G's for two minutes, when he was vertical to the center of gravity (in the supine position)," Dr. Strughold said. (It has been estimated man will have to endure an average of about 5 G's for about three minutes to get into space.)

As research advisor to the school commandant, Dr. Strughold plans the long-range direction of SAM's experiments. About 60% of these are aimed at human survival in space. These efforts are expected to be stepped up further with completion of SAM's new $32 million facility at Brooks Air Force Base, Texas, several miles from the present site.

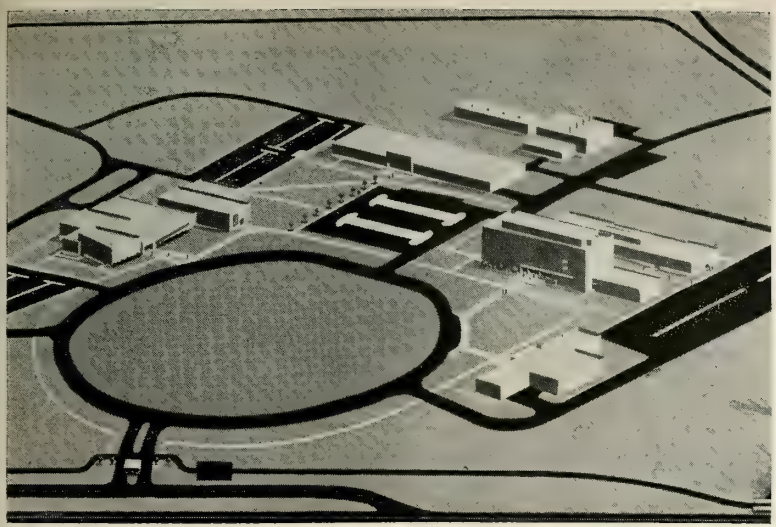
Part of the school's $3 million annual research funds will be used to perfect the closed ecological system. As a starter, Dr. Strughold had the lab technicians build a gas exchange system, in which algae produce the oxygen needed by four white mice—whose exhalations provide the carbon dioxide for the minute plants' photosynthesis.

The mice have survived for periods up to three weeks on the alga-produced oxygen, and could have continued in that atmosphere indefinitely, Dr. Strughold said. Next experiments will use urea as the alga nutrient, as a further step toward achievement of the closed system, which will make possible space trips of months and even years.

• **First space doctor**—Dr. Strughold's researches into the "how" of survival outside the atmosphere and the "what" of life on neighboring planets have paved the way for the new field of astrobiology, brought him international recognition and the first professorship of space medicine. This honor was given the 60-year-old ex-German scientist in March by the Air University, in recognition of his work in SAM's Space Medicine Division. He organized the Division in 1949 and headed it until his appointment as research advisor.

He has received so many awards—national and international—that after his acceptance of the Aero Medical Association's Theodore C. Lyster award last March—his second that month—a friend who congratulated him remarked: "Strugie, this is getting to be downright monotonous."

Recognition had been a long time coming. For many years, Strughold's work to free men from the confines



ARTIST'S CONCEPTION of the new School of Aviation Medicine, which will be located at Brooks Air Force Base, San Antonio, Texas.

of one planet met with the indifference and ridicule familiar to many pre-*Sputnik* space pioneers. However, he found this an advantage when he worked with freedom at the Berlin Aeromedical Research Institute.

• **Tapped by U.S.**—At war's end, Strughold was tapped by the Air Force for the directorship of the American Aeromedical Center at Heidelberg. "The Air Force had been greatly impressed by stories of Strughold's work and his textbook on aero-medical research," explained SAM's Commandant, Maj. Gen. Otis O. Benson, Jr.

Strughold and key members of his group who had escaped the Russian capture of Berlin undertook compilation of German wartime research. This was later published in two volumes as GERMAN AVIATION MEDICINE IN WORLD WAR II. After a thorough investigation, which cleared them of any complicity in war crimes, the group was invited in 1947 to continue their work in the U.S.

The first few years at SAM were not quite what the group had expected. They were not allowed to apply for American citizenship, they were unable to travel without difficulty, they were isolated from the community and they were employed at one pay grade below the equivalent rank of American scientists working for the government.

After taking out their first papers for U.S. citizenship, many of these specialists left the school for posts in universities and industry. Dr. Strughold, who attained citizenship in 1956, stayed with the school despite a number of attractive offers.

Actually Dr. Strughold's Americanization began in 1928, when he came to this country as a Fellow of the Rockefeller Foundation to conduct research in high altitude physiology at Western Reserve University and the University of Chicago.

"When I came back to Wuerzburg in 1929 to teach aviation medicine, my friends said I was not the same—I had become 'Amercanized'."

It was an American—Charles Lindbergh—who first aroused Strughold's interest in aviation medicine. After Lindbergh's transatlantic flight, Strughold began his altitude experiments at Wuerzberg's Physiological Institute, where he was assistant to the eminent Professor Max von Frey.

• **Scientist in action**—More often than not, Dr. Strughold is his own guinea pig. To study the effect of lowered oxygen pressure, he ascended to 12,000 feet in a balloon while recording his own physiological reactions.

Because contact lenses (more practical than glasses in flight operations) were uncomfortable, Dr. Strughold began a study of the ocular nerves. Using a blue dye which colored the nerve endings, he proved that the eye's pain receptors diminish in number from the center of the cornea out. (Lensmakers think it may be possible to construct a lens which rides between the nerve endings.) "The dye was painless," Strughold recalled, "but I went around with deep blue eyes for about two weeks."

While working on problems of weightlessness, he anesthesized his posterior to simulate the anti-gravity effect on the seated pilot. "Pilots really do fly by the seat of their pants," he concluded.

One of his main interests now is the progress of the tiny bits of life which inhabit the Mars jars in SAM's laboratories. First suggested in his book "THE RED AND GREEN PLANET," published in 1953, the experiments indicate that simple forms of life can exist in the somewhat hostile Martian environment where temperatures range from about 75°F. to –95°F.

The jars contain Martian-equivalent gases and soil from the Painted Desert. They have sustained many generations of bacteria, which draw nutriment and oxygen from their slim resources. Some microbes have survived seven months. The next step will show how moss and lichens respond to this treatment.

• **A spaceman dissected**—What kind of man is it whose universe is unlimited; who lives in a world of white mice, Mars jars, sealed space cabins, and compliant plants?

The professor-doctor is a mild-mannered man, whose reddish hair is turning gray. He speaks in a melodic German accent.

Testifying before the Senate Space Committee, Dr. Strughold replied in answer to a question of how he entered the field of space medicine: "I started with aviation medicine in 1927. Entering space medicine was nothing else but a matter of logic."

To his friends he has explained: "I studied everything for fun. When you have this attitude, you often discover things of great interest."

Dr. Strughold's day begins at 8 A.M., when he arrives at his office. He reads the morning mail and research reports, advises the lab on their problems, checks reports, consults with the Commandant, and meets with representatives of industry who are interested in setting up space medicine departments. (Martin Co. has one in the works, Ramo-Wooldridge is in the process and others are consulting with Dr. Strughold on ways and means.)

• **Science and space theories**—The Doctor's thoughts now dwell on the possibilities of plant adaptation. He has read of Russian experiments on cold-resistant plants, which show that plants which are bluish-green have the ability to absorb more heat rays than those found in temperate climates which are yellow-green. These reflect the long-wave rays which are heat carriers. "This helps regulate their temperature," Strughold pointed out.

He believes it is possible to adapt tropical plants to arctic conditions by moving them several latitudes each year and vice versa. "Life is adaptable," he says, "I don't see why not." Extension of this theory into extra-terrestrial life offers interesting possibilities.★

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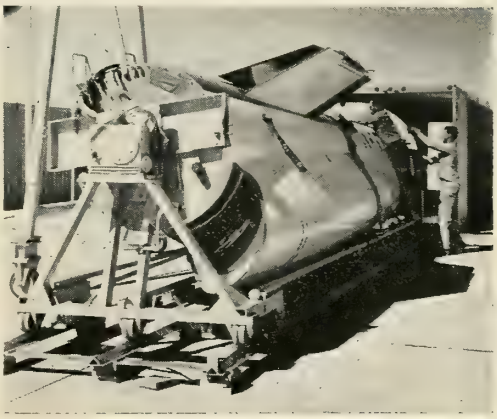
Packaging Missiles for Mobility



Removed from its highway transport van, the nose section is placed on a dolly for later joining with the after section. Nose boom is folded for mobility during shipment to test sites.

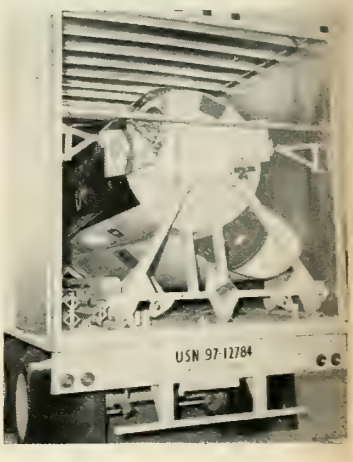
The missile after section is lowered into hanger trailer, and joined to forward section.





Regulus **II completely unloaded from its highway transport container. The missile is shipped in a rotated position for better stowage and safety in the cargo van.**

The rear section packaged and ready for shipment to site.



The Navy's *Regulus* II is one missile that is not dogged with the major logistical problem of mobility, currently plaguing other long range missile systems. This mobility is being demonstrated by transit of the *Regulus* by air and cargo van from the Chance Vought plant in Dallas, Texas, to test sites in California. (See pictures above.)

The missile is broken into two transit containers and moved to the test sites, supplementing the existing practice of flying the completed missile in C-124 Globemasters. For shipment by air, *Regulus* II is rotated about 45 degrees and, with the wings folded, is hauled into the fuselage intact.

A two-van overland shipping unit developed by Fruehauf Trailer is used to transport the missile by highway. Half of the missile goes in each of two containers which are lifted by crane onto truck trailers. Tracks for rolling the missile in and out of the containers are stowed inside each unit. As in shipment by air, *Regulus* II is rotated 45 degrees and its wings and vertical stabilizer folded for stowage.

Chance Vought developed the shipping container method of mobility several years ago for its *Regulus* I. The *Regulus* I was shipped complete in a single truck unit.



Air shipment of the *Regulus* II. With wings and vertical stabilizer folded and tail removed, the missile is rotated 45 degrees and pulled into the fuselage of an Air Force C-124.

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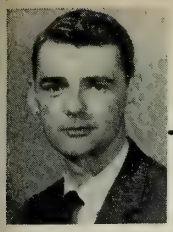
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astrionics

by Raymond M. Nolan

With moon shots in the news these days, it's interesting to remember that the accuracies required for a successful trajectory to impact the moon need only be one-tenth those required for the design objective of *Vanguard*—initial orbital altitude of 300 miles with perigee of 200 miles and apogee of 1,400 miles.

And add this to design problems of the future: Dr. Ernst Stuhlinger of ABMA estimates that, for a proper functioning of a photonic propulsion system, photons of all the wavelengths generated in the conversion system must be reflected and collimated by a mirror with a reflectivity factor of at least 0.999999999. If the photons are created within a container, its walls must have a transmissivity of the same order of magnitude. With anything lower, the mirrors and walls would vaporize from the absorption of energy.

A further advance in inertial guidance seems to be on the threshold of laboratory operation. The electronics division of a large manufacturer claims to have a system which will operate without gyros or gyroscopic accelerometers. Its said to work on the compressibility of fluids.

Newest step forward in micro-miniaturization of electronic modules will probably come from Diamond Ordnance Fuze Laboratories. DOFL's "2D" approach, a two dimensional module with the third, or thickness dimension, as thin as possible, has already resulted in spectacular size reductions. One binary counter module occupies less than 1/150th of a cubic inch. Some of the techniques involved are caseless semi-conductors and scaled-down printed components. One future application reportedly is the Arma *Titan* and *Atlas* guidance and control system. Modules would be mounted on a circular board with a new type of delay line running around the periphery. Some average component sizes: 10K ohm resistor, 60 mils square, 1 mil thick; 0.01 ufd capacitor, 0.1 in. square by 8 mils thick.

Dr. Marcel Golay of Philco's Research Division coins the word "gystat" for the electrostatic gyros under development by the Control Systems Laboratory of the University of Illinois, Minneapolis-Honeywell, and General Electric, among others. The gystat uses a nearly spherical rotor suspended by pairs of supporting electrodes. Additional electrodes form capacitances with the rotor, and are used to sense the three position coordinates and the two orientation coordinates of the rotor. Two shallow zones are cut in the rotor to fix their axis as the one about which the rotor rotates stably, and to provide for differential capacitance changes as the axis of the rotor tilts.

Look for an announcement soon of the decision by a defense manufacturer to produce the wire-guided English Type 891 missile now being manufactured by Vickers Armstrong Ltd. The 891 is an anti-tank missile which is transported under the arm of its one-man crew and launched from the container. Because of rumored difficulties with the anti-tank *Dart*, the 891 might find a ready market until the *Dart* becomes reliable and operational.

A unique "hands-off" partnership is being practiced between the Naval Ordnance Laboratory and Goodyear Aircraft in the *Subroc* program. In areas where either the contractor or the service agency has a decided design advantage, the other partner does not attempt further development on its own. For instance, NOL expects to incorporate a number of new twists already uncovered in the *Polaris* program—Goodyear will accept NOL's design philosophy and attempt no work of its own in these areas except to convert concepts to hardware.

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m/e news



Grid-Frame Tube Seen As Major Electronic Advance

The frame grid tube, a recent significant advance in tube design, is now being mass produced by Amperex Electronic Corp., Hicksville, L.I.

The frame grid construction makes it possible to use extremely fine wire for the grid and achieve the closest approximation now practical to the physicist's "ideal" grid.

This ideal is an infinitely thin conducting plane which offers no resistance to the passage of electrons, except those due to its electrostatic potential. The frame grid construction also results in vastly increased gain-bandwidth product, transconductance and insensitivity to microphonics—all of which make feasible the design and manufacture of more compact and reliable tubes.

What the frame grid is and does may best be understood by comparing it with a conventional grid. In conventional grid construction, molybdenum grid wire is wound helically around two metal supporting rods in which grooves are cut to hold the grid wire in place; the grooves being closed under pressure after the winding is completed.

In this type of construction the grid wire performs both a mechanical and an electronic function. It physically supports the metal rods, and together with two mica spacers, holds them apart at the correct distance. However, this "correct" distance is difficult to maintain because the mica spacers cannot be manufactured to sufficiently close tolerances and the wires, being under tension during the manufacturing process, deform somewhat when released.

• **Construction**—In frame grid construction, the grid wires have only an

electronic function, the mechanical being fulfilled by a sturdy self-supporting frame consisting of two molybdenum centerless ground rods connected by four spot-welded molybdenum strips.

The rods, which can be manufactured to within a tolerance of 0.005 millimeters, determine the clearance between the turns of wire on opposite sides of the frame. This clearance and its accuracy largely determines the grid-cathode spacing, which in turn determines gain-bandwidth product and transconductance.

Very thin tungsten wire, 0.0075 millimeters in diameter, is tightly wound around the frame. The winding tension is about 60% of the tensile strength of the wire. This high tension makes is possible to position the grid wires more accurately and have them maintain their position throughout the life of the tube.

There are several reasons why the frame grid improves performance and reliability. In a vacuum tube, the grid-to-cathode spacing is of prime importance in determining the gain-bandwidth product; the closer the spacing, the higher the product. With the frame grid construction, grid-to-cathode spacing can be reduced to 0.05 millimeters, resulting in a doubling of the gain-bandwith.

Another factor increasing the efficiency of frame grid tubes is the excellent heat dissipation properties of the frame grid structure. The relatively large mass of the frame structure dissipates heat faster than a conventional grid.

The frame grid construction also achieves greater reliability because there is less spread in characteristics before and during use. Variations during manufacturing are at a minimum, because the frame grid structure is such that accurate automatic tooling can be used to produce the high degree of conformity necessary for consistent electrical characteristics. The rigidity of the frame grid structure also makes the tube insensitive to microphonics.

Instrument Behavior Study Under High Speeds

The behavior of instruments for measuring and controlling the flight and re-entry of aircraft, space vehicles, and missiles at hypersonic speeds and at extremely high altitudes is one of the problems currently under study by NACA's Lewis Flight Propulsion Laboratory in Cleveland, Ohio.

To study and analyze instrument behavior under these conditions, Lewis

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Kearfott offers the widest range of synchros in the industry. Ruggedly constructed of corrosion-resistant materials, they give unequalled performance under every environmental condition. For best characteristics and reliability, specify Kearfott for all your synchro requirements. Here are a few typical models:

Size 8: .750" x 1.240". 1.75 oz. −54C to +125C. Available as transmitter, control transformer, resolver, and differential. Max. error from EZ: 10, 7 and 5 minutes.

Size 11 Standard: 1.062"x1.766". 4 oz. −54C to +125C. Available as transmitter, control transformer, repeater, resolver and differential for 26v and 115v applications. Max. error from EZ: 10,7 and 5 minutes standard, 3 minutes in 4-wire configurations.

Size 11 MIL Type: Dimensions and applications same as above. Meets Bu. Ord. configurations: max. error from EZ: 7 minutes.

Size 15 Precision Resolver (R587): With compensating network and transistorized booster amplifier, provides 1:1 transformation ratio, 0° phase shift. Max. error from EZ: 5 minutes.

Size 25 Ultra-Precise: 2.478" x 3.187". 45 oz. Available as transmitter, differential, and control transformer. Max. error from EZ: 20 seconds arc.

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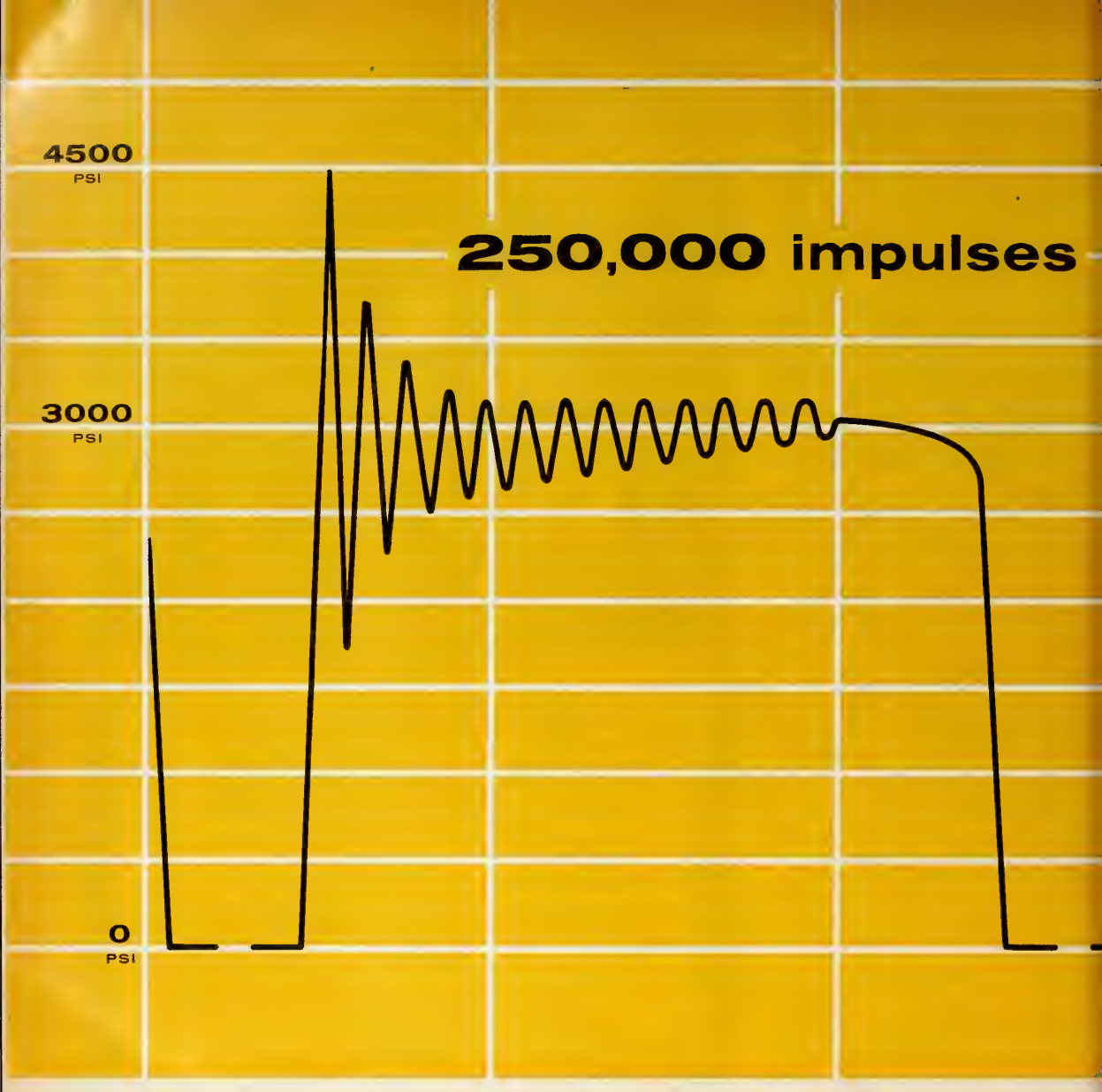
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Resistoflex Corporation announces new 250,000-cycle impulse test standards—for 3000 psi Fluoroflex®-T (Teflon®) hose for hydraulic service at 400° F. These Resistoflex standards replace usual industry standards of 100,000 cycles. Reports of completed tests available on request.

Write Dept. 118, RESISTOFLEX Corporation, Roseland, N. J.

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Circle No. 25 on Subscriber Service Card.

FPL built a special wind tunnel capable of simulating flight speeds in the range from Mach 2 (twice the speed of sound) up to Mach 8, and altitudes on the order of 75 miles.

Experimental designs of air-speed probes and devices for pressure, temperature, velocity, and altitude determination are placed in this tunnel, where their performance under simulated hypersonic flight conditions can be carefully observed.

Performance requirements of this new wind tunnel called for a pumping system of very large volumetric capacity, capable of meeting a specified speed curve over a range of pressures from .05 to 200 microns, and with a maximum air-flow rate of about 44,000 c.f.m. at a pressure of 3 microns.

To meet these requirements, engineers of Lewis FPL selected a specially-designed Stokes high vacuum pumping system, consisting of five 16-inch "Ring-Jet" oil-vapor type booster pumps, with associated valves and fittings. A Stokes (graphic) panel, with schematic representation of all controls, was also supplied.

TI Opens Sales Office In San Francisco Area

Texas Instruments Inc. has recently opened a new sales office for its Semiconductor-Components division in Palo Alto, California.

The office will enable TI to serve its customers better in the expanding San Francisco bay area electronics market. This is the fourth TI office located in the Western states, with regional headquarters in Los Angeles.

The Palo Alto office will be managed by George Pantaze, who has been engaged in a marketing capacity with the TI Semiconductor-Components division in the Western region for two years. His territory includes northern California and Nevada.

Topp Develops Two New Missile Flight Devices

Based on the principle of measured radioactivity, two new missile flight test devices have been developed by Topp Mfg. Co., a division of Topp Industries, Inc.

The first unit, a missile distance indicator (MDI), consists of two basic components—a gamma ray radioactive source and a radiation detector.

The radioactive source, for placement in the missile, is contained in a small screw weighing less than one ounce. The detector, installed in a target drone, counts the amount of radio-

200,000 applications of pressure fail to shake this gauge's accuracy!



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Specifically created for the extremely specialized demands of jet aircraft and missile pressure systems, this gauge is radically different from ordinary pressure gauges. The RMC-Lindsay gauge is a multiple coil, helical bourdon tube type; restricted for overpressure. The pointer is attached directly to the end of the coil, eliminating the use of linkages and pivots.

The bourdon principle itself is not a new development, but the RMC-Lindsay techniques in coiling, heat treatment, calibration and material specifications *are* new . . and *exclusive with RMC*. The Lindsay gauge was invented and developed by Mr. James E. Lindsay, now manager of engineering at RMC of California.

Whatever your high pressure gauge problems may be, why not let RMC engineering skill provide the answers. Write to either plant, or contact one of the RMC representatives listed below:

JOHN FEARON
Boiler Equipment Corp.
P.O. Box 8188, Station F
Atlanta, Georgia

DONALD TATE
Tate Engineering, Inc.
516 S. Eutaw Street
Baltimore 1, Maryland

CHARLES SHEA
J. H. Bertram & Co., Inc.
233 Harvard Street
Brookline 46, Mass.

ROCHESTER MFG. CO., INC.
12143 Halsted Street
Chicago 28, Illinois

HOWARD SNYDER
Benson Engineering Co.
2514 W. Mockingbird Lane
Dallas 35, Texas

J. NEILL ARMSTRONG
J. Neill Armstrong, Inc.
205 Sharrow Vale Road
Haddonfield, New Jersey

WILLIAM RUBLY
Rowe Sales Co.
2140 Westwood Blvd.
Los Angeles 25, Calif.

GEORGE GIBSON
J. Neill Armstrong, Inc.
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New York 17, New York

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Prairie Village 15, Kan.

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West Hartford 7, Conn.

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Benson Engineering Co.
519 S. Broadway
Wichita 2, Kansas

ROCHESTER MFG. CO. OF CALIFORNIA
95 Beacon Place, Pasadena, California

ROCHESTER MANUFACTURING CO., INC.
223 Rockwood Street, Rochester 10, N. Y.

RMC
LINDSAY PRESSURE GAUGES

Circle No. 21 on Subscriber Service Card.

activity in the drone as it rises to a maximum with the missile's approach and then decreases as the missile leaves the target area. The maximum value of the counting rate is then a measure of the distance between the missile and the target.

A feature of the system is that the detector output can be recorded internally in the target for later recovery, or it may be telemetered to a ground station. Output may also be used to actuate a triggering device in a go-no-go system to fire a smoke bomb, flare or other signaling device if the missile passes within a predetermined range.

The radioactive source aids in missile recovery when conventional portable scintillometer equipment is installed in a search plane. It is possible to locate impact sites within one-quarter mile of the radiation source. But, if the missile is buried in the earth upon impact, the source location is then obtained by hand-carrying detection equipment to the site.

Recovery of the radioactive source permits re-use during its entire half-life. Source material may be varied in composition and activation for control of miss distance, operating range, and useful life. Depending upon the application, such materials as cobalt 57, cobalt 60, gold 197, gold 198 and iron 26 may be used. Half-life may be from a few seconds to many years.

Gamma rays from the source material will not effect electronic or mechanical equipment in the missile, nor induce radioactivity in surrounding materials, the company says. Source operation is not effected by heat, acceleration forces, vibrations or low atmospheric pressures.

The scintillation-type detector has a completely transistorized power supply and pulse shaping network. If a battery pack is used, the unit has a life of 10 hours and weighs six lbs. If missile power is used, the 7½-in.-long and 4-in-diameter detector package is reduced to three lbs. Any 28-volt D.X. source may be used with the detector's built-in converter. Temperature ranges for detector operation are from −40°F to 150°F.

The system has an adjustable operational range of miss distances from 2 to 300 feet for relative speeds between the target and missile of Mach 0.5 to Mach 3.0.

Topp's second device for missiles is a 1-lb. material erosion rate instrument (MERI) for installation in a missile nose-cone. The device is designed for continuous telemetry of material erosion rate data back to ground stations.

The basic unit measures 1-3/8″x3-3/8″x5″, and may be installed in the instrumentation compartment with a detector probe mounted next to the inside surface of the missile skin. An activated plug is fitted on the outer skin, at the probe's location, and is impregnated with a radioactive tracer element.

When skin material erodes, radioactive emanation from the wall section decreases. Measurement of the radiation level provides direct measurement of skin thickness to determine the erosion rate.

As with the miss distance indicator, the unit can be used with various radioactive materials and a variety of source strengths.

Indian Head Delivers *Talos* Missile Boosters

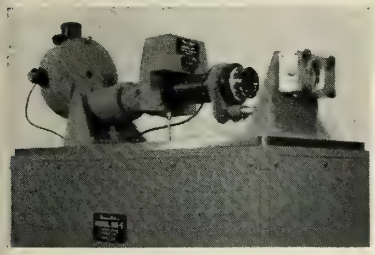
The Naval Powder Factory at Indian Head, Maryland, has started delivery of rocket boosters for the *Talos* missile, according to Captain G. T. Atkins, USN, Commanding Officer.

This solid propellant rocket, which provides take-off power for *Talos*, is one of the largest solid propellant units in production. It was designed by Allegheny Ballistics Laboratory, operated by Hercules Powder Company, under the direction of the Navy Bureau of Ordnance.



Circle No. 23 on Subscriber Service Card.

Research Tool Developed For Photo-Instrument Use



A new research tool for the photo-instrumentation study of self-luminous transient events has been announced by Beckman & Whitley, Inc. The new Model 194 Continuous-Writing Streak Camera produces a documentation designating a plot of space in one direction versus time in a 90-degree direction.

The instrument mounts on its own base and control housing. Standard 35-mm film, arranged for daylight loading and unloading, is used. The image is swept on this film by a rotating triangular mirror driven by a high-speed turbine. Several types of these drives are available. The fastest—ranging from 200 to 5500 revolutions per second—is driven by helium gas.

This arrangement produces a maximum writing rate of approximately 8 millimeters per microsecond, a total writing time at top speed of 58 microseconds, and a maximum time resolution, using a 0.004-in. wide slit image and film having a resolution of 75 lines per millimeter, of 2.5 x 10^{-8}.

Circle No. 239 on Subscriber Service Card.

Cartridge Actuated Cutters Slice Cables Safely



Due to high speed, lightweight cartridge actuated cable cutters are now available that can sever current-carrying cables in a highly explosive atmosphere without hazard.

According to Pitman-Dunn Laboratories, a division of Frankford Arsenal, the 1¼ pound, 5 7/8" cartridge actuated device will cut a ¾" diameter bundle of cables in 4/1000 of a second. The cable cutter is triggered by application of a pulse of high pressure gas from an initiator in the system. A portion of the body is threaded and fitted with two locknuts, to permit mounting the cable cutter in a bulkhead. The yoke portion of the cutter swivels in the body of the device, to permit rotation of the yoke to suit the lay of the cable.

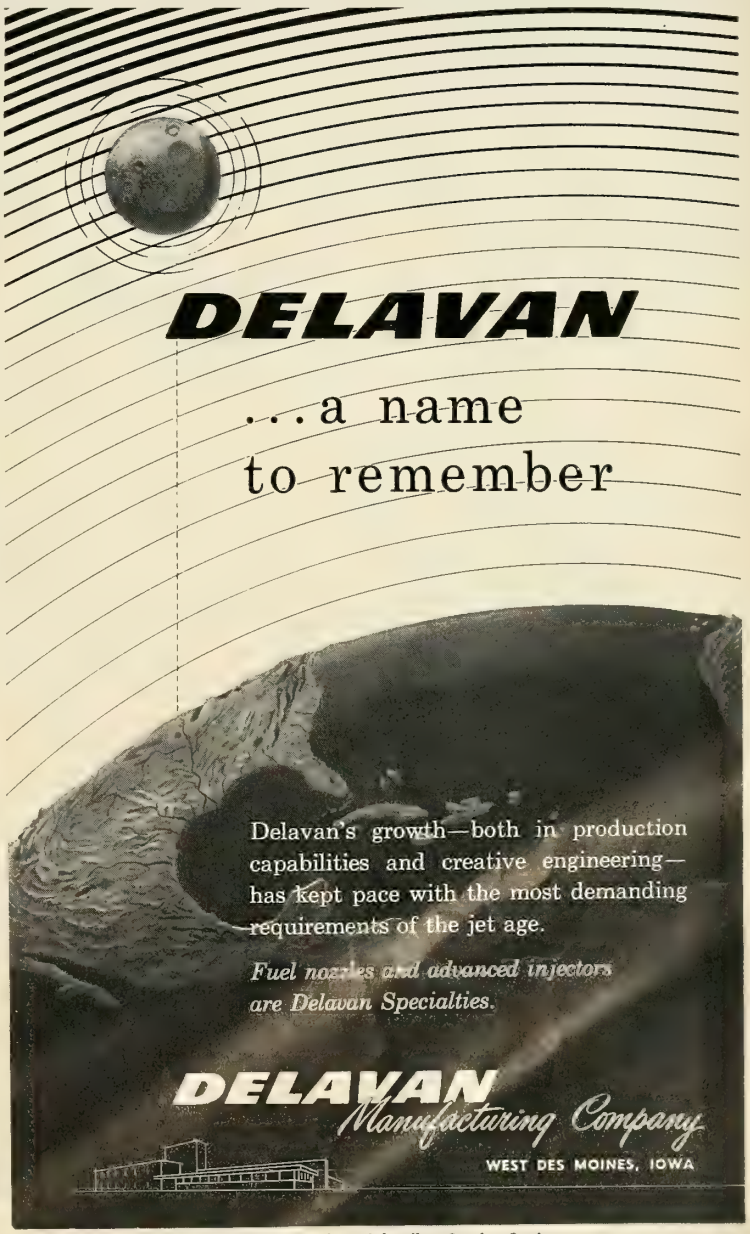
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Gaseal Permits Access To Sealed Equipment

Gaseal, a new, re-usable, leak-tight seal permitting easy access to and resealing of hermetically sealed equipment, is now available from General Hermetic Sealing Corp. Made of seamless, thin-wall metal tubing internally pressurized at 1000 psi, the resilient Gaseal protects systems, subsystems and components from gases and liquids over a wide range of temperatures and under extreme environmental conditions.

Faster service and maintenance of equipment are possible since they may be taken apart and resealed many times, using the same Gaseal. Opening and resealing can be done in less time than required for solder-sealed devices. No heat, special tools or special skills are needed to install or service units.

Circle No. 226 on Subscriber Service Card.



Circle No. 24 on Subscriber Service Card.

letters

Credit for MMPR Forms

To the Editor:

We are writing in reference to the article entitled "U.S. Readies Missile Makers' Planning Forms" (m/r, August 4, p. 12).

We would like to bring to your attention the fact that these forms were not developed solely by Stanford Research Institute. Chronologically speaking, we came in at the tail end of their development, about a year ago—subsequent to at least three and a half years of effort by the three services.

About a year ago, our contracting officer in the Industrial Division of what is now ARGMA was appointed as the Army's representative to the Joint Services Committee working on these missile manufacturer's forms. At this point, the scope of our already existing contract with ARGMA was broadened to include support work for the Army's representative on this committee.

Thus, to correct the statement on page 13, the MMPR forms were developed by the three services, with support from Stanford Research Institute's Economics Division in the latter stages, under a contract with ARGMA's Industrial Division.

Paul Foreman
Operations Analyst
Stanford Research Institute
Washington, D.C.

Everyone concerned is given due credit—Ed.

Encyclopedia Reprints Due

To the Editor:

. . . We wish to have 250 copies . . . which we will distribute to Air Force units for training purposes.

Lt. Col. R. C. Freeman, USAF
Chief, Plans & Development Div.
Directorate of Airmunitions
Ogden Air Materiel Area, Utah

To the Editor:

Your "Guided Missile Encyclopedia" (m/r, July 28) is extremely comprehensive and contains a wealth of information. Congratulations on an excellent job. I hope you will be able to consider our request for twenty-five copies.

Bernard C. Victory
Advertising Manager
Craig Systems, Inc.
Lawrence, Massachusetts

To the Editor:

The encyclopedia . . . is the best thing I've seen on the subject and perfect educational piece for a new comer, like ourselves, to the market We would like reprints . . . to rout throughout our organization.

R. G. Gamble
Advertising Planner
Cummins Engine Co., Inc
Columbus, Indiana

To the Editor:

It is our intention to order 15 copies of the reprint of the "Guide Missile Encyclopedia" . . .

F. E. Fitzgerald
Chief Librarian
The National War Colleg
Washington, D.C.

To the Editor:

We used the "Guided Missile En cyclopedia" from last year's issue wit great benefit . . . we think you hav done a wonderful job on what yo have been able to get together for thi year.

S. H. McAloney
Director, Public Relations
Ford Instrument Co.,
Div. of Sperry Rand Corp
Long Island City, N.Y.

To the Editor:

The "Guided Missile Encyclopedia" was extremely interesting and is ver



NEW limit switchless actuators



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Limit switches are eliminated by two methods: 1) use of continuous stall high temperature motors, 2) use of high temperature motors with thermal protectors which permit maximum *on* time in the duty cycle.

Additional advantages of AiResearch Limit Switchless Actuators: they are smaller, less complex and the possibility of limit switch failure is eliminated.

Development of Limit Switchless Actuators reflects AiResearch experience in producing more than a million rotary and linear units. Current production includes several hundred actuator types, many with high temperature applications.

Your inquiries are invited.

- **A** *Seat Actuator, CONVAIR B-58*
- **B** *Seat Actuator, LOCKHEED F-104*
- **C** *Rotor Blade Trim Actuator*
- **D** *Elevator Actuator, TEMCO XKDT-1 Target*
- **E** *2-Motor Trim Actuator, REPUBLIC F-105*
- **F** *General Purpose Linear Actuator*
- **G** *Dual Purpose Feel Trim Actuator, AVRO CF-105*
- **H** *Rudder Trim, AVRO CF-105*
- **I** *Duct Shutter Actuator, LOCKHEED ELECTRA*

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closely related to our business. This information would prove to be very excellent reference material in our Engineering Department and would also serve to familiarize our junior engineers with the current missile families . . .

L. M. Bachman
Project Supervisor
Thiokol Chemical Corp.,
Reaction Motors Div.

The demand for copies of the Encyclopedia has been so great that we are now preparing a complete reprint . . . which will be ready for distribution at the cost of $1.00 per copy. Any requests for reprints should go to Lawrence Brettner, Circulation Director—Ed.

World Astronautics?

To the Editor:

Congratulations to m/r on becoming a weekly.

I always enjoy reading your magazine and find it a mine of information. I wish, however, that you could find space for news of activity outside America, for although only a limited amount of hardware is actually constructed in other countries, it is quite impossible for the U.S. to cover the whole field of spaceflight. There are many avenues which can and should be explored in other countries.

We in the United Kingdom have long advocated that our country should undertake a spaceflight program in those fields where we could make a useful contribution, and where a dovetailing of activity with the American program would yield mutual benefits.

There is now a strong possibility that the United Kingdom will enter the spaceflight field, even at this late date —with many sidelong glances at its overall financial position. In point of fact, the resources available with the inclusion of Commonwealth scientists are very great, and a significant contribution could be made if official quarters were influenced in this direction.

At a recent Youth Conference, H.R.H. Duke of Edinburgh said, "I personally cannot believe that the British people or the people of the Commonwealth will be content to sit by and watch others explore the Universe around us".

Certainly, the occasion will be unique if, at a time when new and exciting frontiers are opening up for mankind, our country chooses to remain aloof from a job of exploration.

L. J. Carter, Secretary
British Interplanetary Soc.

We anticipated Mr. Carter's letter in m/r, August 18 (p. 33) in an article entitled "Britain, Red China Enter Satellite Race." We mentioned the fact that increasing reports are circulating concerning the possibility of the Red Chinese launching artificial earth satellites. For this reason, The British Interplanetary Society is strongly pressing for establishment of a British space flight program, to offset the propaganda onslaught which would result. British government sources have confirmed hopes of using large powerplants as satellite-launching vehicles—Ed.

We Erred

To the Editor:

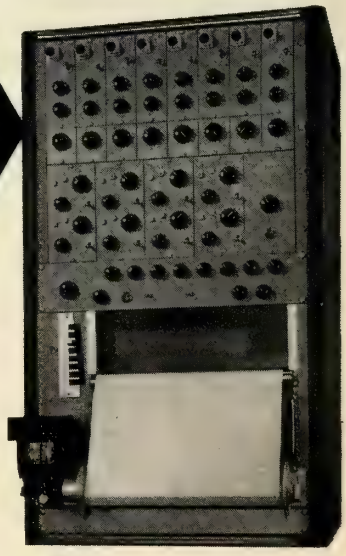
In "New Missile Products" (m/r, May, p. 86), appears a product release with a picture from the Aero Research Instrument Co. In the last sentence of the release, it is stated that "the missile use has been at altitudes of at least 2 x 10 feet, and has survived entry." This quote is incorrect, of course.

The addition of the superscript number "5" behind "10" makes a considerable difference.

L. Scadrom
Aero Research Instrument Co.
Chicago, Ill.

We stand corrected—Ed.

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OFFNER ELECTRONICS INC.
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Circle No. 27 on Subscriber Service Card.

contract awards

LAST MINUTE AWARDS

System Development Corp. got an AMC contract of $29.8 million in connection with Air Defense Command's SAGE computer program.

Metal Products Division of Kippers Co., Inc. was awarded a contract from North American Aviation's Missile Division for design and construction of seven portable silencers for use in testing the GAM-77 Hound Dog.

McDonnell Aircraft received a $5.8 million AF order for production of GAM-72 Quail missile, bringing total Quail money so far to $41.3 million.

Four Wheel Co. received $1.5 million for trans-launcher bogies, part of the Mace missile system.

NAVY

By Bureau of Ships:

Celanese Corp. of America, New York, N.Y. received $65,519 for fluid, hydraulic power transmission safety type.

Anaconda Wire and Cable Co., Hastings-on-Hudson, N.Y., received $73,500 for developing an ultra-high temperature magnet wire suitable for continuous service with repeated cycling within temperature range.

Allen B. DuMont Laboratories, Inc. of Clifton, N.J. received $800,000 for design and development of a special short wavelength radar set.

By Officer in charge of construction, Budocks Contracts, San Francisco:

S. G. Limuaco & Co., Inc., received $63,950 for construction of storage, base rocket assembly.

By Bureau of Ordnance:

Ford Instrument Co., division of Sperry Rand, received $7.4 million for the production of computers for the Tartar missile.

AIR FORCE

By HQ AFOSR, ARDC:

Polytechnic Inst. of Brooklyn, Brooklyn, N.Y. received $90,000 for continuation of research on "three-dimensional supersonic and hypersonic flow problems."

Brown University, Providence, R.I. received $55,600 for research on radiation effects in solids.

University of Maryland, College Park, Md., received $25,725 for continuation of research in micro-wave magnetic spectroscopy of free atoms and free radicals.

Purdue Research Foundation, Lafayette, Ind., received $41,920 for continuation of study of nuclear structure and interactions.

University of Utah received $102,192 for research on "high velocity impact studies."

University of Maryland, College Park, Md., received $62,750 for continuation of research in solid state theory.

University of Minnesota, Minneapolis, received $59,950 for continuation of research on experimental and theoretical research of honey-comb sandwich structures.

Cornell Aeronautical Laboratory, Inc., Buffalo, N.Y. received $125,876 for continuation of research on hypersonic flow by means of the shock tunnel.

University of Minnesota received $116,859 for continuation of research on theoretical and experimental studies of mass transfer cooling.

By HQ, Cambridge Research Center, ARDC:

University of New Hampshire received $75,000 for research directed toward experimental determinations of ionospheric characteristics using satellite radio transmission.

ARMY

By Engineer District, Los Angeles, Corps of Engineers:

Utah Construction Co. Paul Hardeman, Inc., and Manhattan Construction Co. of Oklahoma, San Francisco, Calif. received $5,985,231 for launch complex 65-2 at Cooke AFB.

Price-McNemar Construction Co., Van Nuys, Calif. received $213,500 for Nike improvement program part C at special AAA sites in Los Angeles and Orange Counties, California.

By New York Ordnance District:

Pioneer Chemical Co., Inc., Long Island City, N.Y., received $64,080 for starting mixture, guided missile.

By Los Angeles Ordnance District:

Firestone Tire & Rubber Co. received $2,423,653 for surface-to-surface guided missile.

Douglas Aircraft Co., Inc., Santa Monica, Calif. received $113,225 for launching area items, and also $28,631 for blue streak and emergency repair parts for the Nike system.

North American Aviation, Inc., Canoga Park, Calif., received 2 contracts totaling $180,000 for rocket engines.

General Electric Co., Phoenix, Arizona, received $149,285 for digital computation facility operation.

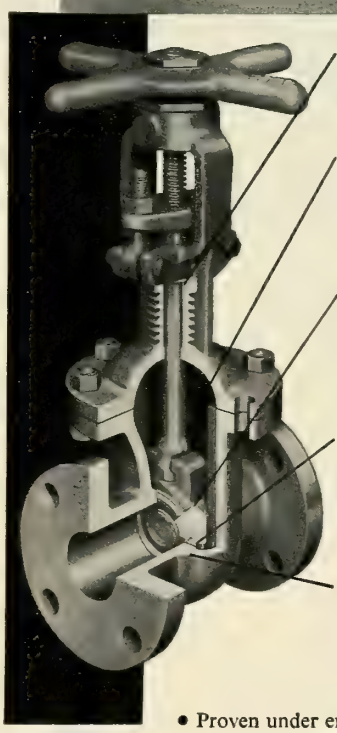
By Corps of Engineers, Omaha District:

George A. Fuller Co., Los Angeles, Calif. received $11,762,420 for construction of launch facilities and utilities.

For Safe, Leakproof Shut-off of Liquid Fuels

SPECIFY:

Hamer Vented Chest GATE VALVES



Chevron Packing
Expands as pressure increases to prevent escapage at stem.

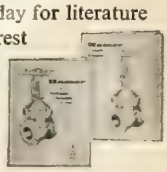
Chest Vented to Pipe Line
Seal on one side vents chest to pipeline, thus preventing locked-in pressure buildups.

Micro-finish Wedge
Seating surfaces are precision finished for exacting metal to metal fit against seats.

Positive Shutoff Seal
Located in one side of the wedge only, this seal compresses against valve seat forming an absolute shut-off.

Integral Body Seat
Integral design eliminates threads, welds & other objectionable surface irregularities.

• Proven under environmental field conditions, these contour engineered Gate Valves seal equally well with line flow in either direction. Seal in one side of wedge vents valve chest to pipeline preventing dangerous pressure buildup. Valves are available in various sizes in a range of metals. Write today for literature and the name of your nearest Hamer representative.



Send for FREE Bulletins LTG, VCG

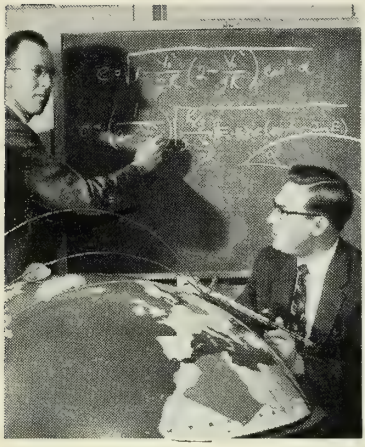
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58-1B Box 1851 — Long Beach 1, California

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HEAVY MILITARY ELECTRONIC EQUIPMENT DEPARTMENT

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COURT STREET, SYRACUSE, NEW YORK

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WHATEVER YOUR FIELD, YOU'LL FIND DRAMATIC OPPORTUNITIES FOR EXPLORATORY WORK AT REPUBLIC IN MISSILE, AIRCRAFT & SPACE TECHNOLOGIES

Advanced nature of work typified by alloy investigation illustrated below

An indication of the way research and development at Republic spans practically the entire field of engineering and scientific endeavor is this partial list of current programs: investigations in magnetohydrodynamics, exotic structural materials, nuclear applications to flight... development of new concepts in hypersonic aircraft, re-entry configurations... new procedures and instrumentation to flight-test missiles, aircraft, satellites and space vehicles.

HOW CAN HEAT TREATMENT BOOST STRENGTH OF MOLYBDENUM ALLOY?

One answer is suggested by this 10,000 X electron micrograph showing precipitated low-temperature-stable phase finely dispersed in matrix material. Grown from atomic size by heat treatment, precipitate induces lattice strains in matrix, imparting high strength properties.



▶ RESEARCH

FLUID DYNAMICS OF ORBITAL SPEEDS IN RAREFIED ATMOSPHERE—AE who can conduct basic research and translate results into practical applications to hypervelocities of upper atmosphere flight. Strong background in aeronautical R&D with theoretical base essential. Advanced degree preferred.

PRELIMINARY DESIGN FOR MISSILE & SPACE PROJECTS—AE with background in 2 or more of these areas: propulsion, aerodynamics, stability & control, trajectory calculation, wind tunnel testing. *Must be able to perform Parametric Studies.* Advanced degree preferred.

OPTICAL & INFRARED TECHNIQUES—as applied to reconnaissance systems development, MS, Physics.

OPERATIONAL ANALYSIS, RECONNAISSANCE & DETECTION SYSTEMS—Experience needed in aircraft or missile technology in electronics, or vehicle performance, or armament, or structures, or applied math. MS in engineering, physics or math.

▶ FLIGHT TEST

ANALYSIS—Power plant performance; stability & control characteristics; other flight test data. AE or ME, 3-7 years relative experience.

DATA REDUCTION—BS or equivalent experience oscillographic data reduction & semi-automatic data reducing equipment.

INSTRUMENTATION—Planning & arranging installation of such systems as: FT photopanel, oscillographic, T/M & magnetic tape recording. Sr Engineer, EE (3-5 years relative experience); Jr Engineer, EE or applied electronic-physics.

ELECTRONIC SYSTEMS—Planning & directing specific FT projects. EE's—3 to 5 years in A/C systems. AE's familiar A/C plus 3-5 years flight test experience. Some Jr EE positions.

DESIGN—EE's or equivalent with 7-10 years wiring design experience. AE able to design instrumentation installations. Familiar with optics, mechanics, high speed photography.

FLIGHT TEST ASSIGNMENT PROGRAMMING—(Also test evaluation; liaison) AE or EE with 3-5 years A/C systems experience. Able to coordinate overall flight test results. Pilot experience desirable but not essential.

AE or ME with 3-5 years flight test experience. Familiar with instrumentation, data analysis, system testing & mission planning.

▶ EXPERIMENTAL DESIGN/TEST

FLUTTER & VIBRATION—Determination of flutter and dynamic loads for high-speed aircraft. Design and testing of flutter models. Positions at different levels. MS-Engineering, Math or Physics with minimum of 8 years experience. BS-Minimum 6 years experience in flutter and dynamic loads.

AERODYNAMICS—Test and analysis of aerodynamic performance related to aircraft, missiles and space vehicles. Positions at different levels. AE—1 to 5 years experience.

ANALOG COMPUTATION—Computation work and the analysis of systems for diversity of upper atmosphere applications. MS or PhD in Physics or Applied Mathematics or Engineering. Minimum 2 years analog experience.

DIGITAL COMPUTER PROGRAMMING—Design and develop Management Control Systems for solution on IBM 704. Program engineering problems involved in aircraft, missile and space vehicle projects. System analysts and programmers. Minimum 2 years programming experience on IBM 704 Computer.

DYNAMICS ANALYSIS—Analysis of radar and guidance systems, servos, analog computers and related areas. Supervisor: EE with 3-5 years experience (Electrical or Electronic).

Also openings for Senior, Principal and Group Engineers. EE's with 2 to 3 years experience.

SYSTEMS ANALYSIS—Analysis of electro-mechanical, electro-hydraulic and mechanical systems for aircraft and missiles. Positions at different levels. ME's with 3-5 years experience.

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Mr. George R. Hickman, ENGINEERING EMPLOYMENT MANAGER

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HOME and ABROAD

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Current openings include **management** positions on the Field Engineering Staff in Detroit and at various field locations.

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MISSILE DIVISION
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Detroit 31, Michigan

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Current Vought hardware includes the F8U jet fighter series and the Regulus guided missiles. Among projects under way are Dyna Soar, ASW studies, spacecraft, other advanced weapons programs. To investigate the key openings described above, qualified engineers are invited to write to C. A. Besio, Supervisor, Engineering Personnel, Dept. P-9.

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advertiser's index

Aerotest Laboratories, Inc.	37
AiResearch Mfg. Co., Div.—The Garrett Corp.	44
Allegheny Ludlum Steel Corp.	11
American Society For Metals	16
Applied Science Corp. of Princeton	6
Avco Mfg. Corp., Research & Advanced Development Div.	4, 52
Bendix Aviation Corp., Red Bank Div.	10
Bourns Laboratories, Inc.	17
Brown Engineering Co., Inc.	42
Brunswick-Balke-Collender Co., The	12
Bulow Electric Co.	25
Cannon Electric Co.	51
Consolidated Controls Corp., Div.—Consolidated Diesel Electric Corp.	34
Delavan Mfg. Co.	43
Electrical Engineering & Mfg. Corp.	8
Ex-Cell-O Corp., Aircraft Div.	31
Foote Bros. Gear & Machine Corp.	36
Genisco, Inc.	18
Goodyear Aircraft Corp., The	3
Hamer Valves, Inc.	47
Ideal-Aerosmith, Inc.	45
Kearfott Co., Inc.	19, 39
LaVezzi Machine Works	16
MB Mfg. Co., Div.—Textron, Inc.	29
Marman Div., Aeroquip Corp.	22
Nutt-Shel Co., Inc.	26, 27
Offner Electronics, Inc.	46
Resistoflex Corp.	40
Rochester Mfg. Co., Inc.	41
Servomechanisms, Inc.	2
Telecomputing Corp.	24

EMPLOYMENT SECTION

Chance Vought Aircraft, Inc.	50
Chrysler Corp.	50
General Electric Co.	48
Republic Aviation Corp.	49

Advertising correspondence should be addressed to Advertising Sales Manager, Missiles and Rockets, 17 East 48th Street, New York 17, N.Y.

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NEW PRODUCT BRIEFS

H PRESSURE GAS PUMP. A new pressure liquified gas pump, which sures only 36 inches overall, but luces pressures up to 10,000 psi flows to 10 gpm, has been deped. The pump is said to be ideally d for trailer mounted oxygen or gen recharges, booster stations, or ade systems. In its portable conation it weighs 400 pounds. Dyic Research Inc.

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VO MOTOR. As a basic actuating ce for AC automatic control and inmentation systems, the Motordyne 1034 subminiature servo motor has rsable operations, high torque-toia ratio, outstanding dynamic reise, and dependable operation for cision airborne applications. Motore, Inc.

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GNETIC CLUTCHES. A line of minre magnetic clutches specially ded for military or commercial con applications has been announced. ignated as Series 1500, these clutches available in double-ended models with servo or flange type mount surfaces. MagneTec Corp.

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CELEROMETER. Friction is said to eliminated in a new A-C linear acrometer, assuring low threshold and standing reliability. Designated the neywell, Type LA-600, the unit con of a non-pendulous seismic mass ported on a frictionless spring susnsion, and incorporates an a-c varie reluctance type pick-off. Minneapoloneywell Co.

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NG LIFE PERFORMANCE. A subniature ceramic capacitor, said to e high reliability over a broad temrature range, and a microminiature y design for maximum vibration and ck resistance, have been announced. ecomputing Corporation.

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SIGNAL TRANSFORMER. A miniature toroidal signal transformer for low-level applications where the user requires high impedance, low phase shift, and minimum pickup, is now available. Arnold Magnetics Corp.

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THERMAL-INDICATOR. The indicator provides a rapid and direct means for accurately measuring temperature. The meter is calibrated in degrees C, and gives a direct reading of the temperature sensed by the Thermal-ribbon. Minco Products, Inc.

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SWITCHING TRANSISTORS. A new line of germanium high frequency transistors has been announced. To be marketed under EIA numbers 2N425, 2N426, 2N427, and 2N428, the new product line features the standard TO-9 package, and is designed to meet or exceed the electrical and mechanical requirements of MIL-T-19500A. Semiconductors Products Division, Motorola, Inc.

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ACID VALVE. A type of valve designed for use with helium and Jp-4 fuel vapor in an atmosphere of inhibited red fuming nitric acid, has been placed on the market. The solenoid operated shut-off valve is leak-proof and operates at a maximum of 1 amp. and 28 volts DC. Randall Engineering Corp.

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POTENTIOMETER. A new rectilinear potentiometer said to meet environmental specifications of MIL-R-19, has been announced. The compact trimming resistor measures only 1¼" in length. DeJur-Amsco Corp.

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CORE WINDER. This newly-developed semi automatic machine winds transformer cores in completely variable lengths, to a maximum of 10" in multiples of three. George Stevens Mfg. Co., Inc.

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26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125
126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150
151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175

• • Missile Literature

200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224

• • New Missile Products

225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245	246	247	248	249
250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	274
275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299

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LIQUATITE DATA. How and where Electri-Flex Liquatite—the liquid tight flexible wiring conduit—protects important wiring circuits from oil, chemicals, water, corrosive fumes and vapors, grease, dirt, salt air and spray, coolants, abrasives, etc., is described in a new two-page data and specification sheet.
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BLIND RIVETS. An eight-page catalogue shows typical design applications of Defco-Seal Blind Rivets, and a three-page evaluation report on these new, positive-sealing fasteners. Catalogue includes application notes, specifications and driving sequence instructions on the rivet, which is designed for application where positive sealing is required.
Circle No. 201 on Subscriber Service Card.

PRECISION STAMPED GEAR. The Fastex Division of Illinois Tool Works has published a 20-page booklet illustrating typical examples of precision stamped gears and listing major applications, size limits, materials and finishes.
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GAUGE SAVER. Automatic shut-off valves for overload protection of gauges and instruments in hydraulic and pneumatic systems are described in a sheet issued by the Sprague Engineering Corp. Six models offer pressure ranges from 10 to 10,000 psi.
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COMPUTER DESIGN. New design techniques to accomplish substantial savings throughout engineering development programs for electronic digital computers are described in a booklet published by Control Data Corporation, Minneapolis computer and control firm.
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ELECTRONIC RESEARCH. Andersen Laboratories, Inc. has issued a four-page bulletin describing its facilities for research, design and manufacture of specialized high quality ultrasonic solid delay lines.
Circle No. 205 on Subscriber Service Card.

TEST INSTRUMENTATION. A new bulletin, W1831, has been released by the Bristol Company as a guide for equipment builders and specifying engineers, outlining Bristol indicating, recording, programming, and controlling instruments for environmental test equipment.
Circle No. 206 on Subscriber Service Card.

SELF-SEALING FASTENERS. A four-page, two-color folder, available from Automatic and Precision Manufacturing Co., describes and illustrates a line of high-pressure self-sealing Seelskrews, Seelbolts and Seelrivits (all registered tradenames) for industrial and military use. The fasteners are said to seal out dust fumes and moisture and were signed for vibration resistance in cri sealing applications.
Circle No. 207 on Subscriber Service C

STABILIZED SERVOMECHANISM. importance of gain variations, which the only parameters over which the signer has control long after the res the system design has been frozen illustrated in a booklet issued by Servo Corporation of America. A gr ical representation of the effects of changes at various points in an ou rate stabilized servomechanism is vided in Paper CP-58-13.
Circle No. 208 on Subscriber Service C

POROUS METAL BEARINGS. The chure presents detailed information DU, U.S. Gasket Company's high- formance, self-lubricated bearing m rial. It describes the advantages of new T.F.E. fluorocarbon resin, lead, ous bronze, steel composite, in typica well as unusual bearing applications.
Circle No. 209 on Subscriber Service C

RELAYS. Universal Relay Corpora has issued a new 16-page illustra folder featuring a wide assortment relays, steppers, solenoids, rectifiers related components. Items shown carried in stock in production quantit
Circle No. 210 on Subscriber Service C

PRODUCTION FACILITIES. New il trated 12-page brochure published The M. W. Kellogg Company contain complete listing of the company's duction facilities for missile and ro programs. It describes in detail exten machining and fabricating shops other equipment and experience the company offers.
Circle No. 211 on Subscriber Service C

BLAST-ETCH MARKING. Recently c pleted bulletins 146-C25 and 146- describe Matthews complete line "Airgrit" Blast-Etch Marking Machi from standard stationary models to p able and inspection type units.
Circle No. 212 on Subscriber Service C

THERMISTOR PROBES. Nine speci designed thermistor probe assemb are described in detail in a new f page brochure issued by Fenwal E tronics, Inc. Each assembly is identif by its most common application, has complete dimensions and mount arrangements.
Circle No. 213 on Subscriber Service C

BALL SELECTOR CHART. The Hartf Steel Ball Co. has prepared a ha chart showing the relative corrosion sistance properties of various ball m rials under extreme conditions of t perature and varied chemical expos
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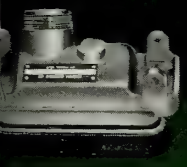
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51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75
76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100
101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125
126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150
151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175
• • **Missile Literature**																								
200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224
• • **New Missile Products**																								
225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245	246	247	248	249
250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	274
275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299

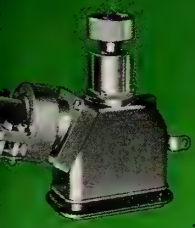
For Other Information Give Page Numbers:_____



AD-Skid Away Release.
or 50 Size 14 Contacts.



MJ-Skid Away Release.
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As a prime contractor on the *Titan* ICBM, Avco has constructed prototypes of the nose cone which embody these critically important breakthroughs, and the "hardware" program based on these advances continues its steady progress.

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9526